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(54) Title: METHOD AND APPARATUS FOR SHOOTING USING BIOMETRIC RECOGNITION

(54) Titre: PROCEDE ET APPAREIL DE TIR UTILISANT LA RECONNAISSANCE BIOMETRIQUE

(57) Abstract

An apparatus for shooting (300). The apparatus includes a gun (302). The apparatus includes a controller connected to the gun which controls whether the gun can fire (304). The apparatus includes a mechanism for determining a present biometric signature of a shooter who desires to fire the gun. The determining mechanism is in communication with the controller. The controller only allows the gun to fire if the present biometric signature of the shooter is recognized by the controller. A method for firing a gun. The method includes the steps of gripping a handle (308) of a gun by a shooter. Then there is the step of recognizing a present biometric signature of the shooter. Next there is the step of releasing a trigger of the gun so the gun can fire as long as the biometric signature of the shooter is recognized.

(57) Abrégé

Appareil de tir (300). L'appareil comprend un pistolet (302). l'appareil comprend un contrôleur connecté au pistolet lequel décide si le pistolet peut faire feu (304). L'appareil comprend un mécanisme destiné à déterminer la signature biométrique présente d'un tireur souhaitant tirer avec le pistolet. Le mécanisme de détermination est en communication avec le contrôleur. Le contrôleur ne permet au pistolet de tirer que si la signature biométrique présente du tireur est reconnue par ledit contrôleur. L'invention concerne également un procédé de tir avec un pistolet. Le procédé comprend les étapes consistant à faire saisir au tireur une poignée (308) du pistolet, ensuite à reconnaître la signature biométrique présente du tireur, puis à libérer une détente du pistolet de manière que celui-ci puisse faire feu tant que la signature biométrique du tireur est reconnue.

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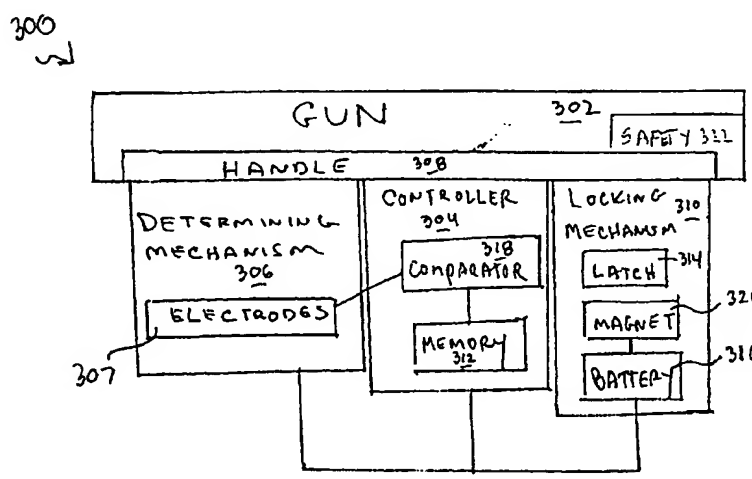

(57) Abstract

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Description

METHOD AND APPARATUS FOR SHOOTING USING BIOMETRIC RECOGNITION

RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application serial number 09/151,908, filed on September 11, 1998.

FIELD OF THE INVENTION

The present invention relates generally to the detection of electric and/or magnetic properties in an individual living organism. More specifically, the present invention relates to biometric recognition wherein electric and/or magnetic properties of a shooter are used to recognize the shooter so the shooter can fire a gun.

BACKGROUND OF INVENTION

Security methods based on memory data encoded into magnetic cards such as personal identification numbers or passwords are widely used in today's business, industrial, and governmental communities. With the increase in electronic transactions and verification there has also been an increase in lost or stolen cards, and forgotten, shared, or observed identification numbers or passwords. Because the magnetic cards offer little security against fraud or theft

there has been a movement towards developing more secure methods of automated recognition based on unique, externally detectable, personal physical anatomic characteristics such as fingerprints, iris pigment pattern and retina prints, or external behavior characteristics; for example, writing style and voice patterns. Known as biometrics, such techniques are effective in increasing the reliability of recognition systems by identifying a person by characteristics that are unique to that individual. Some representative techniques include fingerprint recognition focusing on external personal skin patterns, hand geometry concentrating on personal hand shape and dimensions, retina scanning defining a person's unique blood vessel arrangement in the retina of the eye, voice verification distinguishing an individual's distinct sound waves, and signature verification.

Biometric applications may include but are not limited to, for instance physical access to restricted areas or applications; and access to computer systems containing sensitive information used by the military services, intelligence agencies, and other security-critical Federal organizations. Also, there are law enforcement applications which include home incarceration, parole programs, and physical access into jails or prisons. Also, government sponsored entitlement programs that rely on the Automated Fingerprint Identification System (AFIS) for access are important to deter fraud in social service programs by

reducing duplicate benefits or even continued benefits after a recipient's demise.

Biometric recognition can be used in "identification mode", where the biometric system identifies a person from the entire enrolled population by searching a database for a match. A system can also be used in "verification mode", where the biometric system authenticates a person's claimed identity from his/her previously enrolled pattern of biometric data. In many biometric applications there is little margin for any inaccuracy in either the identification mode or the verification mode.

Current commercially available biometric methods and systems are limited because they use only externally visible distinguishing characteristics for identification; for example, fingerprints, iris patterns, hand geometry and blood vessel patterns. To date, the most widely used method is fingerprinting but there are several problems which have been encountered including false negative identifications due to dirt, moisture and grease on the print being scanned. Additionally, some individuals have insufficient detail of the ridge pattern on their print due to trauma or a wearing down of the ridge structure. More important, some individuals are reluctant to have their fingerprint patterns memorialized because of the ever increasing accessibility to personal information.

Other techniques, currently in use are iris pigment patterns and retina scanning. These methods are being introduced in many bank systems, but not without controversy. There are health concerns that subjecting eyes to electromagnetic radiation may be harmful and could present unidentified risks.

Another limitation of current biometric systems, is the relative ease with which external physical features can be photographed, copied or lifted. This easy copying of external characteristics lends itself quite readily to unauthorized duplication of fingerprints, eye scans, and other biometric patterns. With the advancement of cameras, videos, lasers and synthetic polymers there is technology available to reproduce a human body part with the requisite unique physical patterns and traits of a particular individual. In high level security systems, where presentation of a unique skin or body pattern needs to be verified for entry, a counterfeit model could be produced, thereby allowing unauthorized entry into a secured facility by an imposter. As these capabilities evolve and expand there is a greater need to verify whether the body part offered for identification purposes is a counterfeit reproduction or the severed or lifeless body part of an authorized individual.

U.S. Patent No. 5,719,950 (Osten), incorporated by reference herein, suggests that verifying an exterior specific characteristic of an individual such as fingerprint in correlation with a non-specific characteristic such as oxygen level in the blood can determine if the person seeking authentication is actually present. This method may be effective but still relies on exterior characteristics for verification of the individual. Also, the instrumentation is complicated having dual operations which introduce more variables to be checked before identity is verified.

Current biometric systems are also limited in size. For example, a fingerprint scanner must be at least as big as the fingerprint it is scanning. Other limitations include the lack of moldability and flexibility of some systems which prevents incorporation into flexible and moving objects. Finally, the complex scanning systems in current biometric methods are expensive and this high cost prevents the widespread use of these systems in all manner of keyless entry applications.

Accordingly, there is a need for more compact, moldable, flexible, economical and reliable automated biometric recognition methods and systems which use non-visible physical characteristics which are not easily copied, photographed, or duplicated. This would eliminate concerns regarding fingerprints that are unidentifiable due to dirt,

grease, moisture or external surface deterioration; potential risks involved in eye scanning; costly instrumentation that depends on external characteristics, and the possibility of deceiving a system with an artificial reproduction of a unique external characteristic used for identification.

As an example, an ongoing problem with the use of firearms and weapons generally, is there unauthorized use. Typically, whoever is in possession of a weapon, has the ability to fire the weapon. If, for instance, a policeman on patrol becomes involved in a scuffle and his weapon is knocked from him, his own weapon can be picked up by the villain and fired at him. As another example of many examples, a father keeps a gun in his house for protection but the gun is found by his children. Dire consequences could result if the children were to start playing with the gun and firing the gun. What is desirable is for a weapon to only be able to be fired by an authorized individual so if the weapon is no longer in the possession of the individual, the weapon will not operate.

SUMMARY OF INVENTION

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism for sensing electric and/or magnetic properties of the organism. The apparatus

comprises a mechanism for recognizing the organism. The recognizing mechanism is in communication with the sensing mechanism.

The present invention pertains to a method for recognition of an individual living organism's identity. The method comprises the steps of sensing electric and/or magnetic properties of the organism. Then there is the step of recognizing the organism from the property.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism having a contact area of less than 2.0 centimeters squared to identify an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The sensing mechanism is in communication with the recognizing mechanism so the recognizing mechanism receives the signal from the sensing mechanism.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism having a thickness of less than .2 centimeters to identify an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a

mechanism for recognizing the organism from the attribute. The sensing mechanism is in communication with the recognizing mechanism so the recognizing mechanism receives the signal from the sensing mechanism.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism for sensing an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute with an accuracy of greater than one in a billion.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism which is moldable into a shape having a non-flat surface. The sensing mechanism senses an attribute of the organism and produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The recognizing mechanism is in communication with the sensing mechanism. In the preferred embodiment, the electrodes can be concave, flat, convex, or a combination thereof, lending them to molding into numerous devices. The electrode simply needs to contact the skin of the subject individual.

Characteristics of an organism can be detected by its electrical/magnetic properties, and an individual organism has unique electrical/magnetic properties.

I. The properties can be measured using any mechanism which measures the properties.
   A. The properties can be measured using any mechanism which uses a DC, AC, electric field, magnetic field, and/or EM field.
   B. The properties can be measured using contact and/or non-contact methods.
   C. The properties can be measured by positioning the organism in relation to the applied energy:
      1. as part of an energy flow
      2. interrupting an energy flow
      3. responding to an energy field by generating its own energy flow
         - The properties can be measured using induced currents.
   D. The properties can be measured for a single body segment or for multiple segments. Multiple segments can be compared with each other, i.e., a measured segment from the left hand can be compared to a measured segment on the right hand.

E. The properties can be measured using one or more frequencies.

F. The properties can be measured using one or more waveform shapes.

G. The properties can be measured generating 3 or more dimensional matrices.

H. The properties can be measured using unique sensors.

1. Size
2. Flexibility
3. Moldability

I. The properties can be measured to one in one billion accuracy or greater.

II. An individual organism can be recognized by its electrical/magnetic properties. Any of the mechanisms described in I. can be used for this. Although the absolute measurements will vary slightly from day to day, the relative ratios of the measurements will remain constant enough to derive a biometric pattern.

III. Diagnostic characteristics of an organism can be detected by its electrical/magnetic properties. Positioning the organism in

relation to the applied energy as part of an energy flow, and interrupting an energy flow are described in the prior art. An organism responding to an energy field by generating its own energy flow, such as an induced current is not. Induced currents can be used to measure the electrical/magnetic properties of an organism to determine diagnostic characteristics such as:

A. Presence or absence of bone trauma

B. Presence or absence of tumors

C. Presence or absence of toxins

D. Levels of metabolites

The present invention pertains to an apparatus for identifying electric and/or magnetic properties of an individual living organism. The apparatus comprises a sensing mechanism for sensing the electric and/or magnetic properties. The apparatus comprises a mechanism for forming matrices corresponding to the organism having at least four-dimensions.

The present invention pertains to a method for sensing an induced current in an individual living organism. The method comprises the steps of inducing current in the organism. Then there is the step of detecting the current induced in the organism.

The present invention pertains to an apparatus for sensing an induced current in an individual living organism. The apparatus comprises a mechanism for inducing current in the organism. The apparatus comprises a mechanism for detecting the current induced in the organism.

The present invention pertains to an apparatus for diagnosing a bone. The apparatus comprises a mechanism for inducing a current in the bone. The apparatus comprises a mechanism for detecting a fracture or break in the bone.

The present invention pertains to a method for diagnosing a bone. The method comprises the steps of inducing a current in the bone. Then there is the step of detecting the induced current in the bone. Next there is the step of detecting a fracture or break in the bone.

The present invention pertains to an apparatus for sensing the electric and/or magnetic properties of an individual living organism. The apparatus comprises a mechanism for transmitting electric and/or magnetic energy into the organism. The apparatus comprises a mechanism for receiving the electric and/or magnetic energy after it has passed through the organism.

The present invention pertains to a method for using a computer. The method comprises the steps of sensing

a non-visible attribute of an individual. Then there is the step of recognizing the individual. Next there is the step of accessing the computer by the individual.

The present invention pertains to a method for secure communication between an individual at a first location and a second location. The method comprises the steps of sensing a non-visible attribute of an individual. Then there is the step of recognizing the individual. Next there is the step of allowing the individual to communicate with the second location.

The present invention pertains to an apparatus for shooting. The apparatus comprises a gun. The apparatus comprises a controller connected to the gun which controls whether the gun can fire. The apparatus comprises a mechanism for determining a present biometric signature of a shooter who desires to fire the gun. The determining mechanism is in communication with the controller. The controller only allows the gun to fire if the present biometric signature of the shooter is recognized by the controller.

The present invention pertains to a method for firing a gun. The method comprises the steps of gripping a handle of a gun by a shooter. Then there is the step of recognizing a present biometric signature of the shooter.

Next there is the step of releasing a trigger of the gun so the gun can fire as long as the biometric signature of the shooter is recognized.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may readily be carried into practice, one embodiment will now be described in detail, by way of non-limiting example only, with reference to the accompanying drawings in which:

Figure 1 comprises a block diagram illustrating one preferred embodiment of the present invention.

Figure 2 is a block diagram illustrating a periodic controller connected to a current generator.

Figure 3 is a pictorial representation of a hand attached to a biometric system of the present invention.

Figure 4 is a representative graph of resistance measurement values plotted against multi-frequencies.

Figures 5a-5f are charts of subjects regarding impedance and finger.

Figures 6a-6f are charts of subjects regarding impedance and finger.

Figures 7 and 8 show alternative embodiments illustrating the biometric recognition system utilized in a keyboard and mouse.

Figure 9 is an illustration showing the biometric recognition system of the present invention incorporated into the handpiece of a firearm.

Figure 10 is an illustration showing the biometric recognition system incorporated into a wrist watchband.

Figure 11 is a flow chart of a method of the invention.

Figures 12a and 12b are side and overhead views of a non-contact apparatus for the interruption of an electric field of the present invention.

Figure 13 is a schematic representation of an apparatus for sensing electric or magnetic properties of an organism.

Figure 14 is a schematic representation of an apparatus for sensing the magnetic properties of an organism.

Figure 15 is a schematic representation of an apparatus for inducing current longwise in an organism.

Figure 16 is a schematic representation of the flow of induced current from the heel of the palm lengthwise to the finger tips.

Figure 17 is a schematic representation of an apparatus for the measurement of induced current in regard to a stationary hand.

Figure 18 is a schematic representation of an apparatus for the measurement of induced current in regard to a moving hand.

Figure 19 is a schematic representation of an apparatus for inducing current in an organism using an electromagnetic field.

Figure 20 is alternative embodiment of an apparatus for inducing current in an organism with an electric and/or magnetic field.

Figure 21 is a schematic representation of an apparatus for sensing the interruption of an electromagnetic field.

Figure 22 is a schematic representation of sensing electric and/or magnetic properties based upon reflection of electromagnetic radiation from an organism.

Figure 23 is a schematic representation of an apparatus for measuring the interruption of an electromagnetic field by measuring only the electric field.

Figures 24-33 are circuit diagrams for an apparatus for sensing electric or magnetic properties of a hand piece or mouse or keyboard.

Figure 34 is a schematic representation of a side view of a hand unit.

Figure 35 is a schematic representation of an overhead view of a hand unit.

Figure 36 is a schematic representation of a keyboard having electrodes.

Figure 37 is a schematic representation of a hand grasping a mouse having electrodes.

Figure 38 is a schematic representation of a mouse having electrodes.

Figure 39 is a side view of a wrist band having electrodes.

Figure 40 is a schematic representation of electrode placement and current path of measurement from the palm to the thumb.

Figure 41 is a two-dimensional impedance plot corresponding to the electrode placement of figure 40.

Figure 42 is a schematic representation of measurement sites for back to front capacitive plate measurements from the palm to the thumb.

Figure 43 is a two dimensional impedance plot regarding resistance at a single frequency corresponding to the measurement sites of figure 42.

Figure 44 is a schematic representation of measurement sites from the palm to each finger-tip.

Figure 45 is a three-dimensional plot at a single frequency regarding measurements from the measurement sites of figure 44.

Figure 46 is a four-dimensional plot at four different frequencies from the palm to each finger-tip.

Figure 47 is a schematic representation of electrodes for one finger.

Figure 48 is a three-dimensional plot at a single frequency from electrode to electrode for one finger as shown in figure 47.

Figure 49 is a four-dimensional plot at a single frequency from electrode to electrode for each finger.

Figure 50 is a schematic representation of an acoustic beam at a single frequency passing through the thumb from the side of the thumb.

Figure 51 is a two-dimensional acoustic plot at a single frequency regarding figure 50 where the plot is of amplitude versus time.

Figure 52 is a schematic representation of acoustic energy at a single frequency passing through the side, center and other side of the thumb by varying the location of the thumb relative to the acoustic energy.

Figure 53 is a three-dimensional plot regarding figure 52.

Figure 54 is a four-dimensional plot at four different frequencies through the side, center and other side of the thumb.

Figure 55 is a five-dimensional plot with sine, square and ramped waveforms at four different frequencies through the side, center and other side of the thumb.

Figure 56 is a five-dimensional plot at three different frequencies from electrode to electrode for each finger.

Figure 57 is a six-dimensional plot with sine, ramped and square wave forms at three different frequencies from electrode to electrode for each finger.

Figure 58 is a five-dimensional plot with sine, square and ramped waveforms at four different frequencies from the palm to each finger-tip.

Figure 59 is a picture of a bone with an arrow representing normal current in a bone.

Figure 60 is a picture of a bone having a fracture or break with current interrupted due to the fracture or break.

Figure 61 is a schematic representation of a galvanometer at 0 current reading relative to a bone having a fracture or break where the current has been induced by an apparatus which induces current in a bone.

Figure 62 is a schematic representation of a galvanometer showing normal current in a healthy bone where the current has been induced by an apparatus which induces current in a bone.

Figure 63 is a drawing, actual size, of a 1 cm and 1.25 cm diameter electrode.

Figure 64 is a schematic representation of a cross-sectional enlarged view of an electrode.

Figure 65 is a side view of an electrode.

Figure 66 shows a flip-up sensor.

Figure 67 shows an acoustic mechanism for generation of direct current.

Figure 68 shows an acoustic apparatus for the generation of alternating current and magnetic fields.

Figure 69 shows an apparatus for detection of direct current or alternating current induced by acoustic energy.

Figure 70 shows an apparatus for the detection of alternating current induced by acoustic energy.

Figure 71 shows an apparatus which produces an acoustic wave by electric and/or magnetic energy.

Figure 72 is a schematic representation of an apparatus for shooting of the present invention.

Figure 73 is a schematic representation of a gun in a second stationary unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiments of the present invention and their advantages are best understood by referring to figures 1-11 of the drawings, like numerals being used for like and corresponding parts of the various drawings.

Before explaining the present invention in its best mode, a general explanation of electrical and magnetic properties will help to provide a better understanding of the invention. For purposes herein the term "field" herein

includes but is not limited to waves, current, flux, resistance, potential, radiation or any physical phenomena including those obtainable or derivable from the Maxwell equations, incorporated by reference herein.

The electrical conductivity of a body segment depends upon a number of factors including the length and cross-sectional area of a segment of tissue and the composition of tissue including lean and fatty tissue. There may be day to day variations in conductivity and other electrical measurements due to body weight adjustments and changes in body fluids and electrolyte composition but the changes are fairly consistent through the different body segments being analyzed because of the systemic physical characteristics of each organism. For instance, it is well known in regard to clinical impedance measurements that the impedance variations in a subject due to physiological changes, are smaller than the variability among normal subjects. See "CRC Handbook of Biological Effects of Electromagnetic Fields", generally and specifically pages 8, 9 and 76, incorporated by reference herein.

When measuring electrical and/or magnetic properties of an individual for biometric recognition purposes whether applying energy by the contact method or by the non-contact method, several different measurements may be utilized such as, impedance, resistance, reactance, phase

angle; current, or voltage differential, across a measured body segment. For instance, impedance is a function of two components, that being the resistance of the tissue to the flow of current and reactance which is additional opposition to the current due to capacitant effect of membranes, tissue interfaces, and other biocapacitant tissue.

Many bioimpedance measurements in the prior art depend on the assumption that the relationship of body composition such as body fluid and tissue mass is dynamic, and that fluctuations occur. As fluids increase in the tissue, the bioimpedance signal decreases in value because the segment being measured has an increase in conductive potential due to the increase in fluid volume. Increases in segmental fluid volume will decrease bioimpedance values. Decreases in segmental fluid will decrease the conductive potential and thus increase the bioimpedance value. However, it is known for the operation of the present invention that the daily fluctuation is consistent systemically through the body and the overall ratio between impedance values taken from different segments of a body part will remain constant.

Referring now to the drawings, figure 1 describes a preferred embodiment utilizing an electrical current applied directly to the body part of a testing individual through surface contacting electrodes for generating a biometric pattern of the testing organism. Biometric

recognition system 10 is a device wherein the electric and/or magnetic properties of a body segment is measured by applying an input electrical signal in the form of a constant magnitude current to the body segment tissue and measuring the resulting voltage. Since R=V/I, the measured voltage yields either a relative or calculated resistance. The voltage or resistance pattern is unique for an individual.

It is also contemplated in the present invention that a constant magnitude voltage signal is applied to the tissue and the resulting current is used to determine the bioelectrical characteristics of the testing segment.

For purposes of description, the contact system of the present invention described below uses a constant magnitude alternating current source, but direct current may be used especially in some devices that may require the introduction of an internal battery for a power source. In the event direct current is used in the contact system, an oscillator may be used to convert the direct current to an alternating current. The system 10 comprises a current generator 12 which is connected to excitation electrodes 14, 16 positioned on a body part of a testing individual, such as a hand shown in figures 1 and 3. System 10 further comprises an analyzer 22 which is connected and receives an output voltage signal from receiver electrodes 18 and 20. The analyzer 22 receives the voltage output signal which is

produced between electrodes caused by a flow of current between electrodes 18 and 20 in response to the current flowing from current generator 12. The current generator comprises a current source for generating a constant magnitude current. The identification system of the present invention may utilize a continuous, constant magnitude current or periodic, constant magnitude current. Periodic signals may include sinusoidal, square wave, ramp and sawtooth. Generally, the constant current magnitude ranges from about 1 microamp to 4 milliamps. Typically, the signal frequency may be between about 40 Hz to about 400 MHZ which is a frequency magnitude range within accepted risk standards for electrically susceptible humans. The present invention may utilize a single, predetermined frequency or multiple, variable frequencies within the above disclosed range. It should be noted that any frequency other than that described above may also be used in the present invention as long as electrical and/or magnetic properties of the tissue can be measured accurately. A disadvantage to using frequencies below 40 Hz can be that the measurements take longer and longer fractions of a second to complete. This can lengthen the overall time required to obtain a biometric pattern.

Each different frequency applied in the system has a different effect in the body segment due to membrane physiology, and tissue structure and composition, with accompanying changes in capacitance and inductance. When

using multiple frequencies during the testing mode the output signals provide a unique biometric measurement pattern that is predictive of the individual being tested. The same is also true for changing waveform, angular frequency, capacitance and inductance at a singular frequency, as additional examples.

If a periodic, constant magnitude current is preferred, current generator 12 may be connected to a controller 24 which is capable of generating periodic output signal to control the current generator as shown in figure 2. Bioimpedance measurement systems using a periodic constant current are well known in the art and described in U.S. Pat. No. 5,503,157, the disclosure of which is incorporated by reference herein.

The output signal of the current generator, is transmitted to excitation electrodes 14 and 16 through connectors 15 and 13 respectively. For purposes of illustration, figure 1 shows a tetrapolar electrode placement in which two of the electrodes are active for injecting the current while two electrodes are passive for detecting the resultant signal. It is contemplated that a bipolar setup or two electrodes may be utilized in the present invention especially in systems having minimum surface area for placement of electrodes.

In the tetrapolar electrode system the first excitation electrode 14 may be positioned on the palm heel of the hand while the second excitation electrode 16 is positioned on the palmar tip of the thumb. Similar electrode pairs may be placed and spaced a sufficient distance from each other to provide a drop in voltage on the remaining four digits so that the hand will have at least five distinct segments to be tested. This is by way of example only since other electrode configurations may also be used with the present method.

The present invention prefers the tetrapolar setup of electrodes to overcome the inconsistency that may occur in the impedance measurement values due to external contact resistance. External resistance may change significantly with certain specific changes such as those due to skin moisture. As such, this can be improved by using a tetrapolar system. The tetrapolar electrode system is superior to other electrode systems in that it eliminates both electrode polarization and also contact resistance effects between the electrodes and the body part being measured. Contact resistance is variable with the motion of the subject and creates motion artifacts which interfere with measurement of electrical parameters of the body. By applying the current to the subject through one pair of electrodes and measuring voltage differences through another pair of electrodes, the contact resistance and the inherent

voltage drop is eliminated from the voltage measurement. The path the energy takes is not critical, except that it should approximate the path taken for obtaining the reference pattern.

It should be understood that in some systems of the present invention, the injection of current and the sensing of the voltage may be accomplished with two electrodes for the bioelectric measurements. However, as stated earlier, with the bipolar setup the measured voltages are the voltage drops along the current pathway which include both the internal impedance and the boundary contact impedance. The voltage drop across the contact impedance can be significant compared with the voltage drop across the internal impedance. To overcome this problem when using a two-electrode system a compound electrode may be used. A compound electrode is a single electrode that incorporates an outer electrode to inject the current and an inner electrode to measure the voltage. A suitable compound electrode, for example, is disclosed by Ping Hua, 1993, Electrical Impedance Tomography, *IEEE Trans. Biomed. Eng.*, Jan. 40 (1), 29-34, which is incorporated herein by reference in its entirety. It should be noted that tetrapolar or compound electrodes are not necessary because switching can be used so that transmission and reception from the same electrode does not occur at the same time.

A variety of electrodes are commercially available and well known in the art such that structure and application will not be described in detail. Typically, any type of electrode known in the art that conducts an electrical signal may be used in the present invention. Of particular utility are the current synthetic conductive polymers, including polyacetylene, polypyrrole, poly-3,4-ethylene dioxythiophene, conductive adhesive polymers, semiconducting polymers, conductive silicone rubbers, and conductive rubbers all of which may be used to fabricate conductive inserts in a biometric recognition system such as shown in figures 7-10.

Unit 11, shown in figure 1, provides a surface for placing the measured body part, such as a hand. This unit may be constructed so that the conductive electrodes are mounted on the flat surface of the holder for contact with the fingers, thumb and the palm heel. It should be understood that Unit 11 is only one embodiment envisioned by the inventor.

Since the bioelectrical measurements that are used to recognize an individual include the application or generation of current in the subject, the question of safety arises. As such, the biometric system of the present invention may further introduce the use of a transformer between the signal source generator and contacting electrodes thereby isolating the individual from potential electrical

hazard. Any transformer that will transmit the required frequency associated with the constant current but will not conduct 300 cycles and preferably 60 cycles or higher of voltage in current may be utilized in this system.

Impedance to the current flow in the body segment generates a voltage difference across the body segment. The amplitude of the voltage is modulated by changes in the body segment's electrical conductivity caused by differences in tissues and structures. Receiving electrodes 18 and 20, positioned between the excitation electrodes, in this embodiment, are used to measure the voltage difference produced by the injected current through the measured segment of the body part. The receiving electrodes are generally the same types as that used for excitation electrodes. A voltage signal proportional to the body segments' impedance is generated within the body segment and the voltage difference measured between electrode 18 and 20 is an alternating voltage produced in response to the constant magnitude alternating current. The voltage detector 28 may be any type well known to designers of electronic circuitry such as a voltmeter, potentiometer and the like.

Voltage detector 28 can be of the type that detects the magnitude of the voltage signal and also detects the phase relation between the alternating voltage and the alternating current producing the voltage. Therefore, both

the resistive and reactive components of impedance may be measured. This type of detector is well known to electrical designers and often termed synchronous detectors. Impedance measuring systems utilizing synchronous detectors are described in U.S. Pat. Nos. 3,871,359 and 5,063,937, the contents of which are incorporated by reference herein.

Before the voltage signal is received by the voltage detector 28 and depending on the strength of the signal, an amplifier 26 may be connected between the signal received from the receiver electrodes 18 and 20 and the voltage detector. The amplifiers which can be advantageously used in the present invention are well known and widely used in electronic circuitry art. A suitable amplifier to be used in the present invention will take a signal less than a millivolt and amplify it to volts, will produce a large voltage gain without significantly altering the shape or frequencies present, and provide accurate measurements.

It is further contemplated in the present invention to provide a means to eliminate noise from the signal. As such, a differential amplifier may be used in the present invention to remove background noise. If a differential amplifier is used another electrode will need to be added to the bioimpedance system to serve as a common ground.

Once the voltage signal is measured, the signal may be directed through an analog to digital converter 30 and the digital signal is directed into a microprocessor 32 which can automatically and instantaneously calculate impedance or any of the other bioelectrical characteristics of the body segment. Any general purpose computer or one capable of performing various mathematical operations on the voltage input information may be used in the present invention.

A typical mathematical operation contemplated on the signal within the scope of this invention is the division of one impedance value by a subsequent detected impedance value from a second segment of a body part to compute a comparative ratio. The computation of a representative bioimpedance measurement pattern is illustrated by referring to figure 3. The voltage difference in each of five different segments that being A, B, C, D, and E are detected and subsequently a comparative ratio is determined by dividing one signal detected by a subsequent detected value. As an example A/A, B/A, C/A, D/A and E/A are computed and the resultant values give four comparative ratios for the body part for a predetermined frequency. This yields a ratio of each finger to the thumb, for instance. Then when measurements are taken on another day, even though the absolute measurements will vary, the ratios are still the same(to within 0-6%). If the frequency is then changed, another set of comparative ratios may be determined for the same body part. The more frequencies applied the larger the

set of comparative ratios which may be used as a unique representative bioimpedance measurement pattern. Figure 4 shows a set of the comparative ratios identified above, with series 1 (the thumb) set to 10. The frequencies measured were in Hz (on the horizontal axis 1-15):

10
20
50
100
200
500
1,000
2,000
5,000
10,000
20,000
50,000
100,000
200,000
500,000.

Frequency #10 (10,000 Hz) is an impedance resonance point for the thumb, while the fingers have resonance points around 50,000 Hz.

Figures 5a-5f are charts of subjects showing impedance versus the fingers of the same subjects at

different frequencies. Figures 6a-6f are charts of subjects showing impedance versus the fingers of several subjects at the same frequency.

Another operation contemplated is the computation of impedance values or any of the other bioelectrical and/or magnetic characteristics for each segment for a plurality of frequencies. The results of these values plotted against the range of multi-frequencies will provide a representative bioelectric measurement pattern in the form of a unique curve for each body segment, for example figure 4 shows a plot for segments A-E of figure 3 over a range of multi-frequencies.

The results of the computations are compared with a previously stored reference pattern stored in memory 36 to determine a match within an acceptable error range.

The results from the comparison are displayed on display unit 34 which may be a digital display component of the microprocessor.

While the present invention has been described using the flat hand detector, it should be appreciated that other embodiments of the described system and it elements may be used in other devices to gain access to or activate certain secure systems. For example, figures 7, 8, 9, and 10 illustrate just a few of the contemplated setups and uses for

the biometric recognition utilizing unique electrical conductivity values of an individual.

Figure 7 illustrates a computer keyboard having electrodes imbedded in specific keys for generating bioelectrical conductivity values. If the user's bioelectrical pattern matches that of an authorized individual the computer is activated and the person is allowed to log on.

Figure 8 illustrates another embodiment for access to a secure system using the mouse of a microprocessor. This system will recognize authorized users and prevent others from gaining access to the system.

Figure 9 provides a system to limit the use of a weapon such as a firearm to only the authorized user. If an unauthorized individual attempts to discharged the weapon, the system will not recognize the individual thereby preventing the activation of the firing mechanism.

Figure 10 provides for a simple recognition system that merely provides an individual's biometric characteristic pattern. The measurement electrodes are contained within the watchband wherein conductivity and/or other electrical values are measured in the wrist of an individual. An auxiliary receiving system recognizes the pattern sent from the watch and verifies the identity of the user. This watch, emitting

an unique pattern may be used to open an electronic door lock and replaces the need for a keypad or a remote control unit. Figure 11 is a flow chart of a method of the invention.

Referring to figures 12,13 and 14, the present invention pertains to an apparatus 100 for recognition of an individual living organism's identity. The apparatus 100 comprises a sensing mechanism 101 for sensing electric and/or magnetic properties of the organism. The apparatus 100 comprises a mechanism 102 for recognizing the organism. The recognizing mechanism 102 is in communication with the sensing mechanism 101.

Preferably, the recognizing mechanism includes a microprocessor 103 having a known electric and/or magnetic property of the individual organism. The sensing mechanism 101 preferably includes a mechanism 104 for producing an electric field and/or magnetic field in the organism, and a mechanism 105 for receiving the electric field and/or magnetic field. Preferably, the producing mechanism includes a frequency generator 106 and an electric field transmitter 107 and/or magnetic field transmitter 107 transmitter connected to the frequency generator 106, and the receiving mechanism 105 includes an electric field receiver 108 and/or magnetic field receiver 108 disposed adjacent to the electric field transmitter 108 or magnetic field transmitter and defining a test zone 110 with the electric field or magnetic

field in which a portion of the individual organism is placed for sensing the electric or magnetic properties of the individual organism, and a detector 111 connected to the electric field or magnetic field receiver 108 and the microprocessor 103. The detector mechanism preferably measures phase or amplitude or frequency or waveform of the electric field or magnetic field or acoustic field which extends through the test zone received by the receiver. The apparatus 100 can include a housing 112, and the transmitter and receiver are disposed in the housing. See also U.S. Patent 4,602,639 incorporated by reference, herein.

In operation, a standard frequency generator, well known to one skilled in the art, is connected to an electric and/or magnetic field transmitter, well known to one skilled in the art. For a complete discussion of designing magnetic and electric fields, see "Introduction to Electromagnetic Fields and Waves" by Erik V. Bohn, Addison-Wesley Publishing Co. (1968), incorporated by reference herein. The frequency generator controls and drives the electric and/or magnetic field transmitter which produces an electric and/or magnetic field. Opposing the electric and/or magnetic field transmitter in one embodiment, is an electric and/or magnetic field receiver. Between the electric and/or magnetic field transmitter and the electric and/or magnetic field receiver is a test zone defined by the transmitter's and receiver's location. The test zone is where the individual organism

places a portion of himself or herself, such as a hand, so the hand is in the electric and/or magnetic field that exists between the electric and/or magnetic field transmitter and the electric and/or magnetic field receiver. The presence of the hand, or other portion, causes the electric field and/or magnetic field to extend through the hand and the energy of the electric and/or magnetic field is affected in a unique way corresponding to the individual organism.

The electric and/or magnetic field receiver receives the electric and/or magnetic field. The detector produces a signal corresponding to the electric field and/or magnetic field received by the receiver and provides the signal to the microprocessor. The microprocessor has stored in its memory 113 a known electric and/or magnetic field signal for the individual organism. The microprocessor calls up the stored known signal and compares it to the signal provided to the microprocessor from the detector. If the known signal and the signal from the detector are substantially similar, then the individual organism is recognized.

The detector can measure phase, amplitude, frequency, waveform, etc., of the electric and/or magnetic field which extends through the test zone and the portion of the individual organism in the test zone. Either an electric field by itself, or a magnetic field by itself or a

combination of both can be present for the test zone. If frequency is used for recognition, then preferably the frequency is DC to 500,000 Hertz. If current is used for recognition, then preferably the current is 1 microAmp to 4 mAmp. If potential energy is used for recognition, then the voltage is preferably 0.1 to 15 volts. If waveforms are used for recognition, then sine, ramped, square, or combinations thereof can be used. In regard to the use of an electric field for recognition, preferably an electric field of 20 to 700V/m squared is used. In regard to the magnetic field for recognition, a magnetic field of between 100 mGauss to 10 Gauss is preferred.

Basically, the hand or other portion interrupts a steady electric and/or magnetic field, and the detector measures the amount of interruption. See, U.S. Patent Nos. 4,493,039; 4,263,551; 4,370,611; and 4,881,025, incorporated by reference herein. For an electric field, the measurements could be from the back of the hand straight through to the palmar surface, although it would depend on how the transmitter and receiver are positioned. If a sweeping motion of the hand is used through the test zone, straight through measurements would be obtained first for the thumb, and then for each of the fingers in sequence. This results in five sets of data. In regard to the magnetic field, placement of the hand in the test zone would interrupt the

current induced in the secondary coil from the magnetic flux created by the primary coil, as shown in figure 14.

Preferably, the hand is used as an essential part of the current path. A current is induced by placement of the heel of the palm over a magnetic and/or electric field as shown in figures 15,16,17, and 18 in the embodiment of the apparatus 10, and the induced currents at the finger tips are detected, either with a magnetic and/or electric field sensor.

The present invention pertains to a method for recognition of an individual living organism's identity. The method comprises the steps of sensing electric and/or magnetic properties of the organism. Then there is the step of recognizing the organism from the properties.

The different embodiments described herein revolve about the fact that a subject organism by being somehow present in, or more specifically part of, a circuit that is either electrically based or magnetically based or a combination of both, interferes or affects the energy in that circuit in a unique way. By knowing how the subject individual interferes or affects the energy in the circuit a priori, and then testing again under essentially the same conditions how the subject individual interferes or affects the energy in the circuit, the test information can be

compared to the previously identified information, and the identity of the subject individual can be either confirmed or rejected.

There are many ways this can be accomplished as described above. To summarize, these include but are not limited to the following. A contact technique which measures the electrical properties of the subject individual can be used. A contact technique which measures the magnetic properties of the subject organism can be used. A non-contact technique which measures the electric and/or magnetic properties using steady electrical and/or magnetic field interruption can be used, as shown in figures 12, 13, 14 and 21. A non-contact technique which measures the electric/magnetic properties using induced currents from an electric or magnetic field can be used, as shown in figures 15, 16, 17, 18, 20 and 22. A non-contact technique which measures the electric/magnetic properties using steady electromagnetic field interruption can be used, as shown in figure 21. The non-contact method which measures the electric/magnetic properties by reflection of an electromagnetic field can be used, as shown in figure 22, and where only one field is detected as shown in figure 23. A non-contact technique which measures the electric/magnetic properties using induced current from an electromagnetic field can be used or an acoustic field as shown in figures 67-71. These are but some examples of how electrical or

magnetic properties of an individual can be determined for recognition purposes.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism having a contact area of less than 2.0 centimeters squared to identify an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The sensing mechanism is in communication with the recognizing mechanism so the recognizing mechanism receives the signal from the sensing mechanism. Preferably, the recognizing mechanism is in contact with the sensing mechanism. The contact area of the sensing mechanism is preferably less than .2 centimeters thick. In the preferred embodiment, a single acoustic transducer having about a 1.5 cm^2 surface area was used to detect a biometric recognition pattern. The acoustic transducer surface is less than 2 mm in thickness.

Figure 63 shows an actual size of a 1 cm diameter and 1.25 cm diameter thin electrode for sequential grasping between the thumb and fingers. Figure 64 shows a cross-sectional view of the electrode. Figure 65 shows a side view of the electrode. Figure 66 shows a flip-up sensor. This sensor can be only as thick as two pieces of

metal foil and an insulator. It can be on a hinge so that it is flush with a surface until it is used. Then it is flipped up at right angles to the surface.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism having a thickness of less than .2 centimeters to identify an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The sensing mechanism is in communication with the recognizing mechanism so the recognizing mechanism receives the signal from the sensing mechanism.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism for sensing an attribute of the organism. The sensing mechanism produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute with an accuracy of greater than one in a billion.

In the preferred embodiment, 9 out of 10 imposters can be eliminated with a single frequency scan. There are significant electric/magnetic pattern differences at least every 50 Hertz. Scanning from 50 Hertz up to 500, 000 Hertz,

yields 10, 000 significant patterns. If a different 9 out of 10 imposters are eliminated at every different frequency, then an accuracy is attained of 1 in 1 times 10 to the 10, 000 power of people. The entire world population is only 8 times 10 to the 9 power of people, rounding to 1 times 10 to the 10 power. Accordingly, an accuracy for 1,000 times the planet's population is attained. However, only a different 9 out of 10 imposters at 10 different frequencies are needed to be eliminated in order to be accurate for the entire world. The present invention is able to eliminate a different 9 out of 10 imposters for at least 25 different frequencies.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism which is moldable into a shape having a non-flat surface. The sensing mechanism senses an attribute of the organism and produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The recognizing mechanism is in communication with the sensing mechanism. In the preferred embodiment, the sensing mechanism can be concave, flat, convex, or a combination thereof, lending them to molding into numerous devices. The sensing mechanism simply needs to contact the skin of the subject individual. In a preferred embodiment, plastic piezoelectric material was used for the molded

surface. Piezoelectric film sensors can be purchased from the AMP Piezo Film Sensor Unit in Valley Forge, Pa, incorporated by reference herein. Alternatively, see "Piezocomposite Transducers- A milestone in ultrasonic testing" by G. Splitt, incorporated by reference herein. In addition, rigid acoustic transducers can be curved concave, or curved convex, or beveled or faceted surfaces can also be used.

The present invention pertains to an apparatus for recognition of an individual living organism's identity. The apparatus comprises a sensing mechanism which is flexible. The sensing mechanism senses an attribute of the organism and produces a signal corresponding to the attribute. The apparatus comprises a mechanism for recognizing the organism from the attribute. The recognizing mechanism is in communication with the sensing mechanism. In a preferred embodiment, an acoustic biometric sensor made of plastic-type piezoelectric material, as identified above, can be used which results in a flexible sensing mechanism.

Preferably, the sensing mechanism is made of rubber, plastic, metal, mineral or ceramic or composites. Because an electrode need only to be able to contact the skin of the subject individual, the electrode surface can be flexible. By being able to bend or compress, flexible electrodes can be built into a watch and its bands or jewelry

or items of clothing, leather luggage or plastic credit cards without any affect on the functionality of the article being attached with the flexible electrode. For instance, there can be a plastic identity card with a name and picture, and a thumb electrode on one side and two or three finger electrodes on the other side. The card can be slid one quarter inch down into a reader and the electrodes grasped. The reader compares the pattern of the subject individual who is contacting the thumb electrode and two or three finger electrodes to the pattern stored on the card.

Referring to figures 24-33, there are shown the circuit diagrams regarding a preferred embodiment of the apparatus for recognition that can be connected to sensors or electrodes. Except as indicated, all decimal capacitance values are in μF, and all whole-number capacitances are in pF. All resistances are in ohms.

The system contains a waveform-generation stage, a waveform-detection stage, and associated digital logic. The system allows up to 8 connections to a person for measurement.

The frequency range of the waveform-generation stage is approximately 75 Hz to 1.2 MHZ. To generate this signal, a voltage-controlled oscillator (U13) is used. The voltage used to tune the oscillator is generated by U11, a

12-bit D/A converter. This converter conveniently uses a serial input, so only 3 wires are required from the microcontroller to set the voltage output instead of the customary 12. The VCO tunes from approximately 300 kHz to 1.2 MHZ, a coverage range of approximately 1 to 4. Output from the VCO is approximately a square wave.

The VCO is fed into a 12-bit ripple counter, U15, in order to make lower frequencies available. The ripple counter is wired to divide the VCO output frequency by powers of 4; e.g., the output frequency is divided by 1, 4, 16, 64, 256, 1024, or 4096. One of these outputs is selected by quad NAND gates U5 and U6. Each possible divisor is assigned to one input of its own NAND gate. The other input from each gate is set by the microcontroller to enable the correct divisor only. As the microcontroller has a limited number of pins, an 8-bit parallel output serial shift register, U14, is used to reduce the number of connections required from 7 to 2 by allowing the NAND gate mask to be transmitted serially from the microcontroller.

As the D/A and VCO sections may exhibit some frequency drift over time, one of the divider outputs is connected to one of the microcontroller I/O pins. This permits the microcontroller, which contains a time reference which is locked to a ceramic resonator, to determine the actual VCO frequency for calibration purposes. The accuracy

of this determination is limited by the resonator's tolerance and is 1% or better.

The outputs of the NAND gates are shaped with RC filters to limit the spectrum of the output waveform to what is intended. As square waves contain a very high-frequency component at the time of each state transition, the wave shapes are modified so that they are somewhat rounded. This ensures that the frequency being measured by the waveform-measurement stage is the frequency which was intended for measurement.

After the RC filters, the frequency-divided outputs are summed to a common point and passed through a capacitor to remove the DC bias. Note that only one output should be transmitted at a time (although it is possible to program the microprocessor to output multiple frequencies, this is not normal operation). The signal is fed, with the DC bias removed, to a CMOS analog multiplexer, U7, to distribute the signal to a point on the subject's hand; e.g., a finger or the wrist. The signal at this stage is approximately 1 volt peak to peak. U7, by the way, takes its address and enable inputs from another parallel output serial shift register, U9, for the same reasons that U14 is present elsewhere.

The waveform-measurement stage begins with a set of eight input amplifiers based on the LT1058 quad JFET input

precision high-speed op-amp (U3, U4). Its pin-compatible with many other quad op-amps including the LM324. The LM324 cuts off around 20 kHz, and response past 1 MHZ is needed. The voltage gain is set at 2:1 but can be adjusted by altering resistor values. The issue is ensuring that sensitivity is adequate without overloading the analog MUX inputs on U8. Remember that the full output of the waveform-generation stage will be on one of the MUX pins, while the low level at another pin is being routed to the detector.

The CMOS analog multiplexer, U8, is used to route the signal from the appropriate hand connection (e.g., finger or wrist) to the detector. The address and enable inputs for this MUX also come from U9.

A half-wave diode detector is used to rectify the AF or RF signal and provide a DC level which is usable by the A/D converter. Because the diode has a forward voltage drop of around 0.3 V, a 0.3 V bias voltage is used to keep the diode at the threshold of conduction for small signal detection. The bias voltage is generated by reference to an identical diode.

The A/D converter, U10, is microprocessor compatible meaning that its outputs can be switched to high impedance. This permits the same connections to be used for other purposes. Of the eight output pins, seven are

dedicated to the A/D converter, but one doubles as the data pin for the serial input chips, U9, U11, and U14. This works because the microcontroller lines are bidirectional, and the serial input chips are not clocked during A/D transfers to the microcontroller. To further complicate things, the ten A/D output bits are stuffed into eight wires, meaning two wires are used to read two bits each. This is accomplished by initiating two read cycles from the microcontroller.

The microcontroller, U16, is a BASIC Stamp II from Parallax, Inc. It has a built-in serial interface with a line receiver, "fakes" a line transmitter with a resistor (works for most computers, but some might have trouble as the logic levels aren't standard—see the documentation from Parallax), 16 I/O lines, 26 bytes RAM, 2048 bytes EEPROM, and a BASIC interpreter in ROM. The controller is very easy to use and programs in a BASIC dialect. It should be noted: pin 3 of U16 must be connected when programming the microcontroller, but must be disconnected immediately after programming and prior to use. This disconnection is shown on figure 33.

To read an impedance, the following steps must be performed by the microcontroller. This is generally in communication with a host computer such as a notebook computer running Windows 98 and appropriate software. The microcontroller software is already written, and serves to

accept commands from the host computer and return readings as appropriate.

1. Set the D/A converter to output a voltage which causes the VCO to oscillate at the desired frequency. This is within a range of 300 kHz to 1.2 MHZ. This step is performed by sending a 12-bit signal to the D/A converter via the 3-wire serial interface A0, A11, and A12.

2. The frequency output by the VCO should be measured by counting the pulses on the appropriate microcontroller pin (A13) over a fixed period of time. The D/A converter output can be adjusted as necessary to ensure that the correct frequency is produced.

   (This step can be done either in real time, or more preferably as a pre-operation sequence to produce a frequency calibration curve. The unit will not drift appreciably during a usage session, but might over weeks or months. It also requires this frequency calibration prior to being placed in service. This step can be entirely user-transparent.)

3. The input and output MUX channels (fingers or wrist) must be selected. This is done by sending an 8-bit signal to U9 via the 2-wire serial interface A0 and A10.

4. The appropriate frequency divider output (1, 4, 16, 64, 256, 1024, or 4096) must be selected. This is done by sending an 8-bit signal (7 bits are used) to U14 via the 2-wire serial interface A0 and A14.

5. A brief settling time (10 ms is adequate) should occur to allow the capacitor in the signal detector to reach equilibrium with the new measured value.

6. The A/D converter is read. This is accomplished using A0 through A7 for data, A8 and A9 for control. The chip is actually read twice to obtain all ten bits of the result; refer to the manufacturer's documentation. Do not forget to set A0 as an input pin for this step; it is used at other times as an output pin for serial data.

The data read by the A/D converter will require numeric adjustment via some

calibration curve to represent an actual impedance. This curve will be sensitive to frequency on account of the RC filters and frequency response of the input amplifiers, MUX, and signal detector circuit. A "calibration plug" with fixed impedances in place of a handpiece has been fabricated to allow the system to produce calibration curves for this purpose.

7. A15 is connected to a piezo buzzer to allow the microcontroller to make appropriate noises as desired by the programmer. Alternatively, A15 may be used to drive a small speaker through appropriate circuitry—the microcontroller can generate as many as two audio frequencies at a time on this pin using pulse width modulation.

For a discussion regarding transducers and acoustics generally, see "Encyclopedia of Acoustics" by Malcolm J. Crocker, John W. Ley & Sons, Inc., incorporated by reference herein.

There are various embodiments for biometric units such as hand units 125 that are used for recognition purposes. These hand units can be used as a key to start or

allow access to a computer, vehicle or other object. A signature signal is sent by wiring, or by transmission, to a computer. The computer processes the signal and either compares it to a known signature signal of the organism already stored in the computer's memory, or prepares it for further transmission to a remote location, or both. Alternatively, instead of simply allowing access or activating a computer once recognition is attained, a constant signal of the person holding or operating the hand unit, mouse or the keyboard can be sent from the computer through a modem either directly to a remote party or through the Internet to assure the party at the remote site that the person at the keyboard or mouse who is in communication with the remote party, is the desired person. In this latter scenario, the assurance is then maintained over time that the person who has the proper recognition to activate the computer does not then turn the control of the computer over to a third party who does not otherwise have access to the computer, and appropriate the computer for subsequent operations under the authorized persons name, such as sending or obtaining information or purchasing goods or services from a remote location which requires the identity of the authorized person. The computer can also keep a log of who accessed a site and when.

Generally, six electrodes are used for hand units. All connections are made through the 9 pin connector that is

standard on the back of a computer tower or desktop, although the 25 pin printer port can also be used. The pins used on the 9 pin connector are the same ones for each hand unit. The electrodes can be conductive metallic foil, plastic, or rubber. They can be flat (about 2 centimeters times 2 centimeters) or molded for finger tips (taking into account the large variations in size). For a simple hand unit that will be used for recognition, a flat reversible hand unit can be used for the right or left hand as shown in figures 34 and 35. Electrodes are placed in the following regions: 1) heel of the palm (a long electrode strip or a single small electrode movable on a spring); 2) thumb tip; 3) index finger tip; 4) middle finger tip; 5) ring finger tip; 6) little finger. The hand unit must be adaptable for large or small hands. It is made out of clear plexiglass for each surface. There is a hollowed out area for the heel of the palm to fit into, and also for the finger tips. The entire hand area could be hollowed out a little to produce more consistent hand placement. The hand piece is fabricated using brass inserts pressed through plastic sheets for the electrodes.

In regard to a keyboard 126 as shown in figure 36, electrodes can be placed at the (t), (7), (9), (p) keys and a 4 centimeter strip can be placed on the left end of the space-bar and a palm strip on the lower frame of the keyboard. Conductive rubber keys for the keyboard, at least at these locations, would be preferred. This embodiment on a

keyboard would be appropriate for activation as opposed to continuous indication of the presence of an authorized user, since the user would not be able to maintain contact with all the electrodes continuously. The wiring from the electrodes on the keyboard can run with the normal keyboard wiring to the computer, or to the 9-pin or 25-pin connections.

A mouse 128, as shown in figures 37 and 38 could also be prepared for recognition. Conductive foil strips or imbedded conductive polymers that attach flat to the surface of the mouse for the palm and each finger tip would allow easy grasping over time of the mouse. A variation of requiring the user to continually hold the mouse along the foil strips can be established, where a time period exists which requires the user to grip the mouse at least once during each time period so the computer is not shut off. The keyboard and mouse preferably use Compac aluminized tape with conductive adhesive for the electrodes. The wiring from the electrodes on the mouse can run with the normal keyboard wiring to the computer, or to the 9-pin or 25-pin connections.

A wrist band 129, as shown in figure 39, made of elastic material can be used to simulate a wrist watch. Electrodes can be conductive foil attached to the inside of the band. A transmitter of the wrist band can transmit the individual's signature obtained with the electrodes by the

push of a transmission button or by periodic automatic transmission. The transmission of the signature will then be received by a device that will have or has access to the person's known signature, and recognition will then be confirmed or denied for whatever the application or purpose. For instance, the watch can be activated by proximity to a wall unit. The wall unit recognizes the watch and gives entry. For this, the wall unit would recognize the watch on the person. Basically, the whole transmission is proximity detected. The watch has a transmitter and receiver. The wall unit emits a radio signal which is received by the receiver of the watch, causing the watch to transmit the biometric signal. The wall unit receiver receives it and compares it with known authorized signatures. If a match occurs, the wall unit allows current to flow to a lock mechanism in the door, disengaging the door lock so the door can be opened. The wrist band could be used with a personal area network, see "Personal Area Networks: Near-Field Intrabody Communication" by T. G. Zimmerman, Systems Journal, Vol. 35, No. 314, 1996, MIT Media Lab, incorporated by reference herein.

In a preferred embodiment, and referring to figures 40-58, multidimensional matrices such as three and four dimensional matrices are formed for recognition purposes. Acoustic biometric scans can produce three-dimensional patterns at one frequency, and four-dimensional patterns at

multiple frequencies. The electric/magnetic techniques described herein produced two-dimensional scans at a single frequency and three-dimensional matrices when multiple frequencies are used in regard to a single segment of the subject organism. In the electric/magnetic techniques, if there are multiple sensors along the current path, such as shown in figures 40, 42 and 44 there would be for instance 8 different readings for the palm to thumb-tip current, at one frequency. That would produce a two-dimensional reading for the thumb and a three-dimensional plot for all five fingers. Extending this to multiple frequencies would yield a four-dimensional plot of the subject organism, as shown in figures 46 and 49. By varying the waveform and switching patterns, five and six-dimensional matrices as shown in figures 56-58 are attained.

Scans on the thumb of several people all at a single frequency resulted in unique signatures corresponding with the individuals which allowed for easy identification of the individuals. For a single frequency scan, in its simplest form, a two-dimensional plot was obtained, with amplitude on the Y axis, and time on the x axis as shown in figures 50 and 51. For a multiple frequency scan, a three-dimensional plot was obtained with frequency on the Z axis. The mode that was used to obtain the result was the "radar" type mode, with a single transducer working in what is known as the "pulse-echo mode". Preferably, only one transducer

was used and excellent results were achieved, although more than one transducer could have been used.

In the radar type mode, the acoustic energy was transmitted by the single transducer in contact with the skin of the subject organism. The acoustic energy was released essentially in a well defined short burst and as the energy passed through the subject organism, portions of it over time were reflected as the energy moved through the soft and hard tissue of the subject organism. The echo or reflection of the energy back to the transducer over time yielded the signature of the subject organism.

In its more complex and preferable form, three-dimensional scans were produced at a single frequency. One side of the thumb was scanned to the other, for a total of 25-35 scans per person. Each single scale was two-dimensional, and when combined in a group, with location plotted on the Z axis, yielded a three-dimensional ultrasonic topography of the thumb, as shown in figures 52 and 53. If the three-dimensional ultrasonic topography is extended to multiple frequencies, a four-dimensional plot results, with frequency on the W axis, as shown in figure 54. If waveform is varied, a five-dimensional plot results, as shown in figure 55.

In the preferred embodiment, medical frequencies in the low MHZ range (2.25 MHZ; 0. 7 to 1. 8 millimeters wavelength) were used and were able to detect all the detail necessary, and even actually more than necessary, to obtain a unique signature. This is why a two-dimensional scan at a single frequency is able to be obtained.

It should be appreciated that although the detection of induced current can be used for biometric recognition, the detection of induced current can be used for other purposes such as for diagnostic purposes including bone. In a normal bone, an induced current will flow through the bone since the bone is a conductor, as is well known in the art. See, "Radiofrequency Radiation Dosimetry Handbook", Fourth Edition, October, 1986; USAF School of Aerospace Medicine, Aerospace Medical Division (AFSC), Brooks Air Force Base, TX 78235-5301, incorporated by reference herein. See figure 59. However, when the bone has a fracture or break in it, the current will be interrupted due to the break or fracture and will prevent the current from flowing or substantially reduce the current from flowing that would have otherwise flowed if the bone did not have a break or fracture. As shown in figure 61, an apparatus for inducing an electric current in the bone, as described above, can have a galvanometer which reads the current flow which is induced in the bone, or in the case of a fracture or break, the lack thereof. Figure 62 shows an apparatus to induce current in

the bone with a galvanometer that shows expected and normal current flow through the bone.

The present invention pertains to an apparatus for identifying electric and/or magnetic properties of an individual living organism. The apparatus comprises a sensing mechanism for sensing the electric or magnetic properties. The apparatus comprises a mechanism for forming matrices corresponding to the organism having at least four-dimensions.

The present invention pertains to an apparatus for diagnosing a bone. The apparatus comprises a mechanism for inducing a current in the bone.. The apparatus comprises a mechanism for detecting a fracture or break in the bone.

The present invention pertains to a method for diagnosing a bone. The method comprises the steps of inducing a current in the bone. Then there is the step of detecting the induced current in the bone. Next there is the step of detecting a fracture or break in the bone.

The present invention pertains to a method for sensing an induced current in an individual living organism. The method comprises the steps of inducing current in the organism. Then there is the step of detecting the current induced in the organism. Preferably, the detecting mechanism

detects a characteristics of the organism associated with the induced current.

The present invention pertains to an apparatus for sensing an induced current in an individual living organism. The apparatus comprises a mechanism for inducing current in the organism. The apparatus comprises a mechanism for detecting the current induced in the organism. Preferably, the detecting mechanism detects a characteristics of the organism associated with the induced current.

The present invention pertains to an apparatus for sensing the electric and/or magnetic properties of an individual living organism. The apparatus comprises a mechanism for transmitting electric and/or magnetic energy into the organism. The apparatus comprises a mechanism for receiving the electric and/or magnetic energy after it has passed through the organism.

The present invention pertains to a method for using a computer. The method comprises the steps of sensing a non-visible attribute of an individual. Then there is the step of recognizing the individual. Next there is the step of accessing the computer by the individual.

The present invention pertains to a method for secure communication between an individual at a first

location and a second location. The method comprises the steps of sensing a non-visible attribute of an individual. Then there is the step of recognizing the individual. Next there is the step of allowing the individual to communicate with the second location.

The present invention pertains to an apparatus for sensing the electric and/or magnetic properties of an individual living organism. The apparatus comprises a mechanism for transmitting acoustic energy into the organism. The apparatus comprises a mechanism for receiving electric and/or magnetic energy generated in the organism due to the acoustic energy after it has interacted with the organism.

The present invention pertains to a method for sensing the electric and/or magnetic properties of an individual living organism. The method comprises the steps of transmitting acoustic energy into the organism. Then there is the step of receiving electric and/or magnetic energy generated in the organism due to the acoustic energy after it has interacted with the organism.

Impedance and phase angle resonance frequencies can also be used for recognition. For instance, a person can grasp a transducer with the thumb and forefinger with the transducer providing a multifrequency scan point of the thumb and forefinger. Each organism for a given body segment has

a unique impedance or phase angle resonance frequency that can be used to recognize the organism.

Figure 67 shows the acoustic generation of direct current. An acoustic generating system provides energy to a piezoelectric material. The acoustic energy will travel through the body segments and a direct current will be generated. The direct current will be generated in the semi-conductor structures. Figure 68 shows the acoustic generation of alternating current and magnetic fields. An alternating current will be generated in the semi-conductor structures whose natural oscillating frequency matches the acoustic frequency. This will in turn produce a magnetic field. Figure 69 shows the detection of direct current or alternating current induced by acoustic energy. The acoustic generating system is connected to the piezoelectric material which results in acoustic energy traveling through the body segments. In turn direct current results which is detected by electric field detectors such as capacitors. Figure 70 shows the detection of alternating current induced by acoustic energy. At a single frequency the locations are mapped out of the structures producing the alternating current, by detection with magnetic field detectors. Figure 71 shows an acoustic wave induced by electric and/or magnetic energy. The acoustic analysis system receives induced acoustic waves from an acoustic transducer which results from electric/magnetic energy interacting with the body segments

that have arisen from an electric and/or magnetic transmitter.

Referring to figure 72, the present invention pertains to an apparatus 300 for shooting. The apparatus 300 comprises a gun 302. The apparatus 300 comprises a controller 304 connected to the gun 302 which controls whether the gun 302 can fire. The apparatus 300 comprises a mechanism 306 for determining a present biometric signature of a shooter who desires to fire the gun 302. The determining mechanism 306 is in communication with the controller 304. The controller 304 only allows the gun 302 to fire if the present biometric signature of the shooter is recognized by the controller 304.

Preferably, the gun 302 includes a handle 308 and the determining mechanism 306 includes electrodes 307 disposed in the handle 308 and adapted to contact a hand of the shooter when the shooter grips the handle 308 with the hand. The gun 302 preferably has a trigger and wherein the controller 304 includes a locking mechanism 310 operationally engaged with the trigger which releases the trigger so the gun 302 can be fired as long as the controller 304 recognizes the present biometric signature of the shooter.

Preferably, the controller 304 includes a memory 312 having a known biometric signature of the shooter, and a

comparator 318 which compares the known biometric signature with the present biometric signature and releases the locking mechanism 310 as long as the present biometric signature is recognized. The locking mechanism 310 preferably includes a latch 314 engaged with the trigger which prevents the trigger from firing the gun 302 when the latch 314 is closed.

Preferably, the locking mechanism 310 includes a magnet 320 which is activated as long as the present biometric signature of the shooter is recognized, said magnet 320 when activated moving the latch 314 into an open position so the gun 302 can fire. The locking mechanism 310 preferably includes a battery 316 in the gun 302 handle 308, and wherein the magnet 320 includes a coil connected to the battery 316 which receives present from the battery 316 to create a magnetic field.

The present invention pertains to a method for firing a gun 302. The method comprises the steps of gripping a handle 308 of a gun 302 by a shooter. Then there is the step of recognizing a present biometric signature of the shooter. Next there is the step of releasing a trigger of the gun 302 so the gun 302 can fire as long as the biometric signature of the shooter is recognized.

In the operation of the invention regarding a gun 302, a shooter grabs the handle 308 of the gun 302 with the

hand. The gripping action of the hand on the handle 308 causes electrodes 307 in the handle 308, which extend to the surface of the handle 308, to contact the hand, allowing for the present biometric signature of the shooter to be acquired through the electrodes 307. The present biometric signature obtained by the electrodes 307 is sent through wires to a comparator 318, also disposed in the handle 308 of the gun 302. The comparator 318 is connected to a pre-stored known biometric signature of the shooter. The comparator 318 compares the known biometric signature of the shooter with the present biometric signature of the shooter.

When the comparator 318 recognizes the present biometric signature of the shooter, the comparator 318 produces an output signal that is passed to a switch, such as a transistor, also in the handle 308 of the gun 302. One port of the transistor is connected to a battery 316 in the gun 302 and another port of the transistor is connected to the comparator 318 to receive the output signal from the comparator 318. When the output signal is received from the comparator 318 by the transistor, the electricity from the battery 316 is able to flow through the transistor to a wire coil connected to the transistor. When the electricity flows through the wire coil, a magnetic field is created which attracts a latch 314 that is also positioned in the gun 302 so it cannot be removed without dismantling the gun 302. The latch 314 is positioned in front of the trigger so that the

latch 314 blocks the trigger from being pulled and thus the gun 302 being fired when the latch 314 is closed. When electricity flows through the wire coil, a magnetic field created in the wire coil creates a magnetic attraction which pulls the latch 314 toward it and away from the trigger so the trigger is free to fire. The electricity flows through the wire coil as long as the shooter grips the handle 308 and the present biometric signature of the shooter is recognized by the comparator 318.

When the shooter releases the handle 308, the present biometric signal which needs to be present to be recognized by the comparator 318, disappears and the transistor stops any further flow of electricity from flowing through to the wire coil. A spring having a spring constant less than the magnetic force created by the magnetic field, and which is compressed when the magnetic field pulls the latch 314 away from the trigger, now expands, causing the latch 314 to move back into position, preventing the gun 302 from firing.

Alternatively, the latch 314 can be positioned between the hammer and the bullet of the gun 302 so the hammer cannot strike the bullet as long as the latch 314 is in place. Or, there can be two latches, one engaged with the hammer in a closed state and the other engaged with the trigger in a closed state. Furthermore, instead of a gun 302

having only a single known biometric signature stored in a memory 312 register of a comparator 318, a computer chip can be connected to a memory 312 having a table of acceptable shooters. When the present biometric signature is received by the computer, the computer sorts through the table of known biometric signatures to recognize the present biometric signature so the known biometric signature can be provided to the comparator 318 so the comparator 318 can produce the output signal when the present biometric signature is recognized.

The safety 322 of a gun 302 can be employed with recognition. The safety 322 can be connected with the battery so that when the safety 322 is on, not only is the gun 302 incapable of firing, but no electricity flows from the battery to the electrodes 307 or the switch, thus conserving the energy of the battery. In one embodiment, the electrodes 307 can only obtain a present biometric signature of a shooter when the safety 322 is off. In another embodiment, the safety 322 can be on and instead of stopping any electricity flowing from the battery, the present biometric signature must be continuously recognized, as explained above, so the gun 302 can fire. If it is desired to avoid the need altogether for biometric signature recognition in the gun 302 in this embodiment, the safety 322 is turned off and the gun 302 is able to fire without any recognition of the shooter whatsoever. In this instance,

when the safety 322 is switched off, it can mechanically force the latch 314 out of the way of the trigger and be held out of the way, by, for instance, a lever connected with the safety 322 that is turned as the safety 322 is turned.

In yet another embodiment, instead of the recognition occurring continuously in order for the gun 302 to be able to fire, the recognition can be established initially, causing the latch 314 to move out of the way of the trigger, and thereafter, or if a timer is in place, for however long the timer is set, the latch 314 will stay out of the way of the trigger and the gun 302 can be fired by anyone. A simple timing mechanism such as an RC circuit can be used to allow the latch 314 to move back into place after the predetermined time.

Alternatively, as shown in figure 73, a second stationary unit 324 can be used to hold the gun 302. The second stationary unit 324 has a biometric recognition system, such as a hand unit or electrodes 307 which are gripped by the shooter to allow the shooter to be recognized, as described above. The second stationary unit 324 acts as a lock on the hammer or the trigger and when the recognition occurs, the second stationary unit 324 releases the gun 302, allowing the shooter to lift the gun 302 out of the second stationary unit 324 and take it away or hand it to someone else to use. The second stationary unit 324 has a locking

mechanism which fits about the hammer of trigger and holds the gun 302, such as a ring that is made of two pieces. When recognition occurs, a motor causes the ring, which acts much like a clamp, to separate so the gun 302 can be removed. When the gun 302 is put back, the shooter presses the rings closed.

Although the invention has been described in detail in the foregoing embodiments for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as it may be described by the following claims.

Claims

WHAT IS CLAIMED IS:

1. An apparatus for shooting comprising:

a gun;

a controller connected to the gun which controls whether the gun can fire; and

a mechanism for determining a present biometric signature of a shooter who desires to fire the gun, said determining mechanism in communication with said controller, said controller only allowing the gun to fire if the present biometric signature of the shooter is recognized by the controller.

2. An apparatus as described in Claim 1 wherein the gun includes a handle and the determining mechanism includes electrodes disposed in the handle and adapted to contact a hand of the shooter when the shooter grips the handle with the hand.

3. An apparatus as described in Claim 2 wherein the gun has a trigger and wherein the controller includes a locking mechanism operationally engaged with the trigger which releases the trigger so the gun can be fired as long as

the controller recognizes the present biometric signature of the shooter.

4. An apparatus as described in Claim 3 wherein the controller includes a memory having a known biometric signature of the shooter, and a comparator which compares the known biometric signature with the present biometric signature and releases the locking mechanism as long as the present biometric signature is recognized.

5. An apparatus as described in Claim 4 wherein the locking mechanism includes a latch engaged with the trigger which prevents the trigger from firing the gun when the latch is closed.

6. An apparatus as described in Claim 5 wherein the locking mechanism includes a magnet which is activated as long as the present biometric signature of the shooter is recognized, said magnet when activated moving the latch into an open position so the gun can fire.

7. An apparatus as described in Claim 6 wherein the locking mechanism includes a battery in the gun handle, and wherein the magnet includes a coil connected to the battery which receives present from the battery to create a magnetic field.

8. A method for firing a gun comprising the steps of:

gripping a handle of a gun by a shooter;

recognizing a present biometric signature of the shooter; and

releasing a trigger of the gun so the gun can fire as long as the biometric signature of the shooter is recognized.

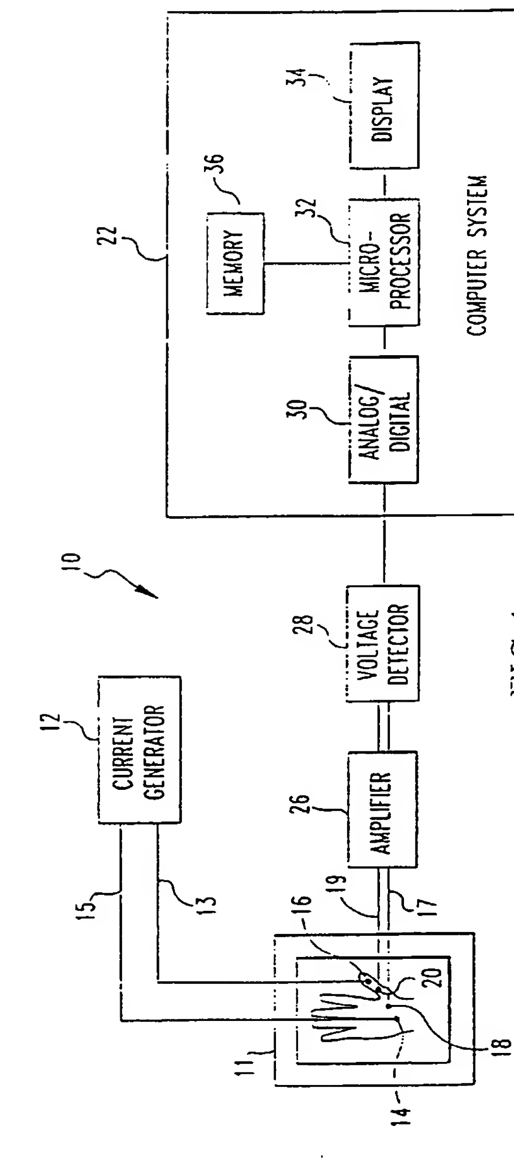

CURRENT GENERATOR
AMPLIFIER
VOLTAGE DETECTOR
ANALOG/ DIGITAL
MICRO- PROCESSOR
MEMORY
DISPLAY
COMPUTER SYSTEM
10
11
12
13
14
15
16
17
18
19
20
22
26
28
30
32
34
36

FIG.1

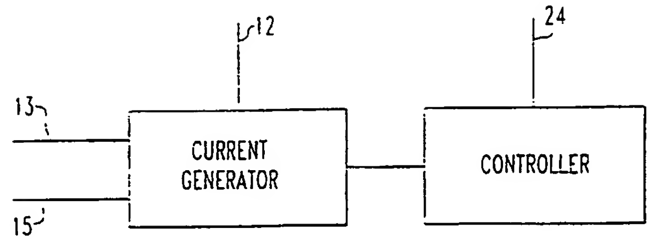

12
24
13
15
CURRENT GENERATOR
CONTROLLER

FIG.2

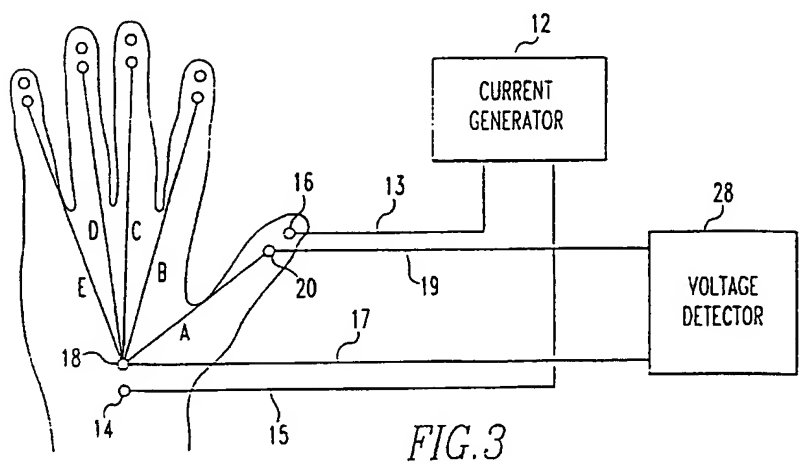

12
CURRENT GENERATOR
28
VOLTAGE DETECTOR
16
13
20
19
17
18
14
15
A
B
C
D
E

FIG.3

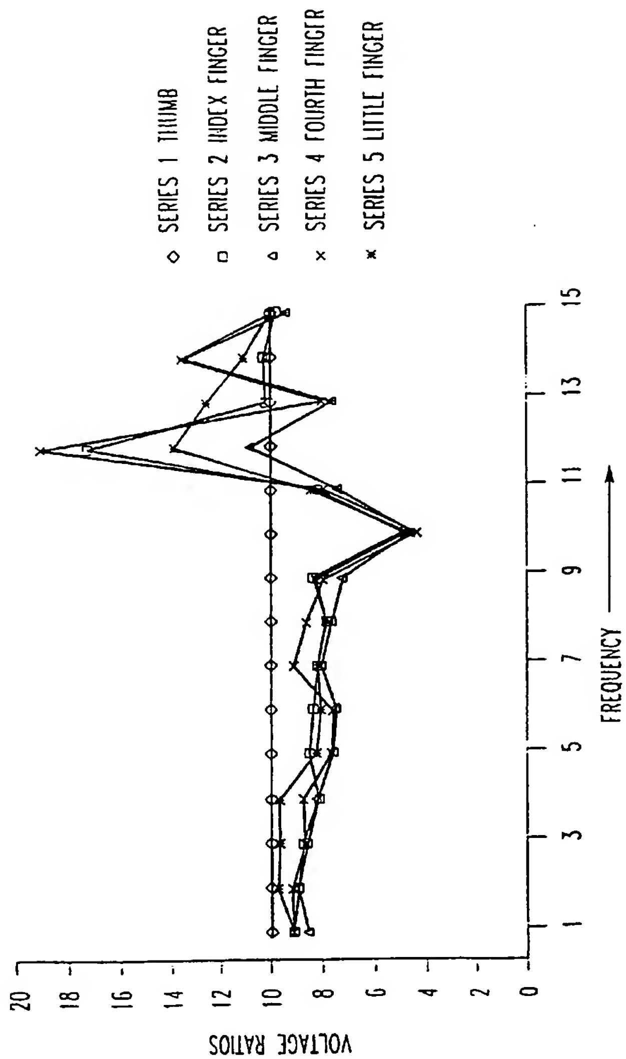

SERIES 1 THUMB
SERIES 2 INDEX FINGER
SERIES 3 MIDDLE FINGER
SERIES 4 FOURTH FINGER
SERIES 5 LITTLE FINGER
VOLTAGE RATIOS
20
18
16
14
12
10
8
6
4
2
0
1
3
5
7
9
11
13
15
FREQUENCY

FIG. 4

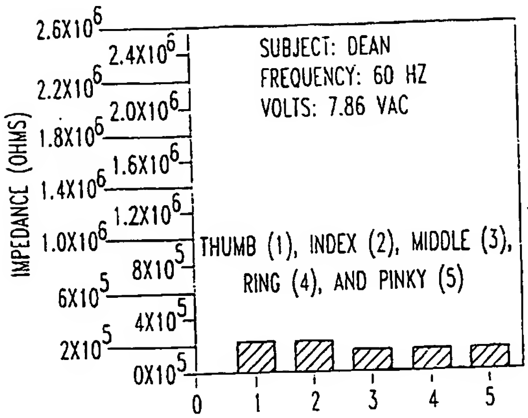


FIG. 5A

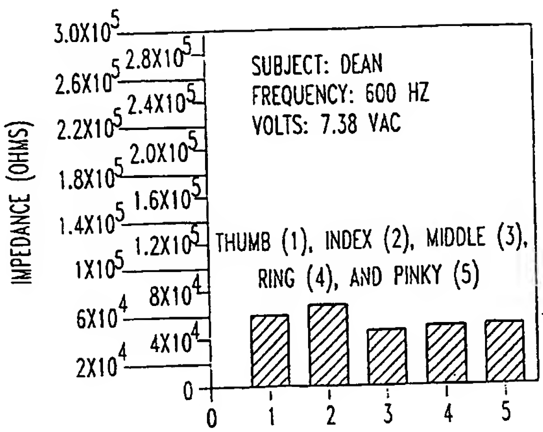


FIG. 5B

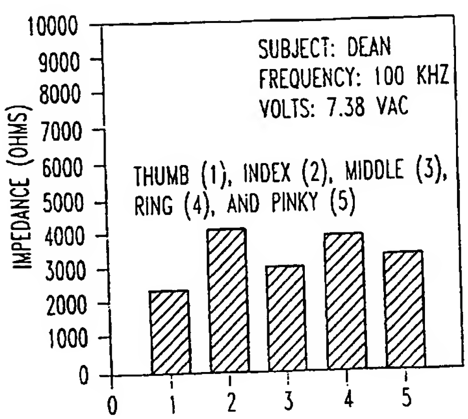


FIG. 5C

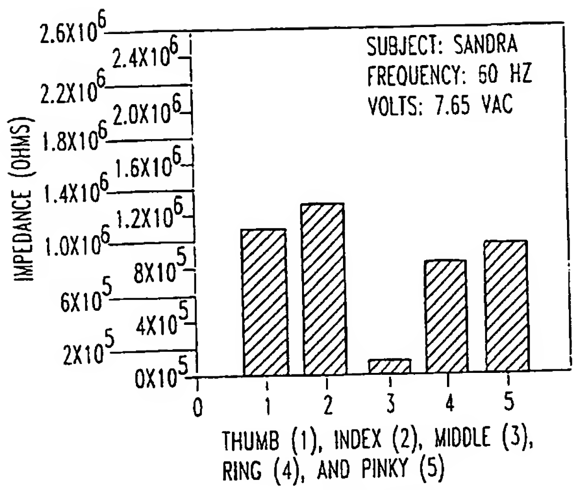

SUBJECT: SANDRA
FREQUENCY: 60 HZ
VOLTS: 7.65 VAC
IMPEDANCE (OHMS)
2.6X10^6
2.4X10^6
2.2X10^6
2.0X10^6
1.8X10^6
1.6X10^6
1.4X10^6
1.2X10^6
1.0X10^6
8X10^5
6X10^5
4X10^5
2X10^5
0X10^5
0
1
2
3
4
5
THUMB (1), INDEX (2), MIDDLE (3),
RING (4), AND PINKY (5)

FIG.6D

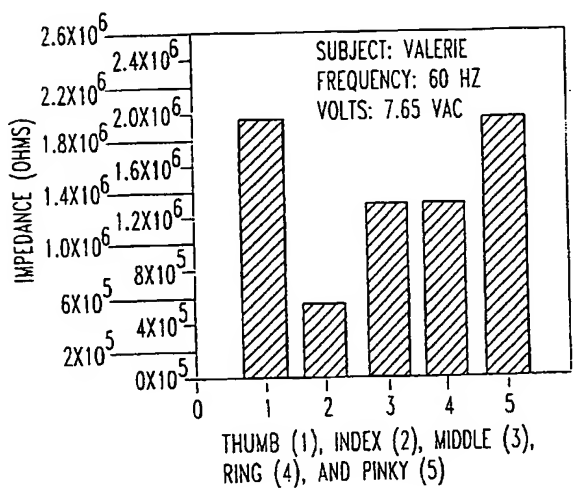

SUBJECT: VALERIE
FREQUENCY: 60 HZ
VOLTS: 7.65 VAC
IMPEDANCE (OHMS)
2.6X10^6
2.4X10^6
2.2X10^6
2.0X10^6
1.8X10^6
1.6X10^6
1.4X10^6
1.2X10^6
1.0X10^6
8X10^5
6X10^5
4X10^5
2X10^5
0X10^5
0
1
2
3
4
5
THUMB (1), INDEX (2), MIDDLE (3),
RING (4), AND PINKY (5)

FIG.6E

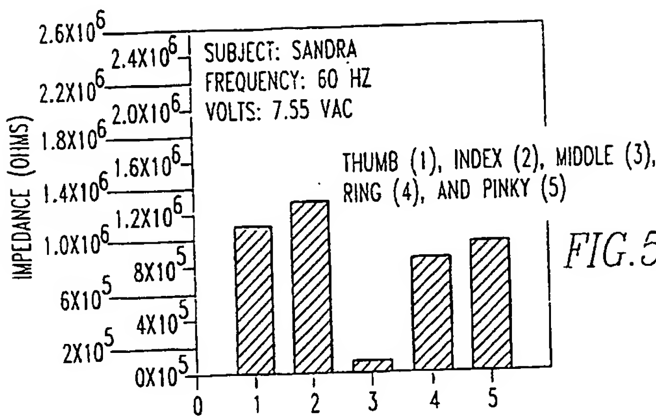


FIG.5D

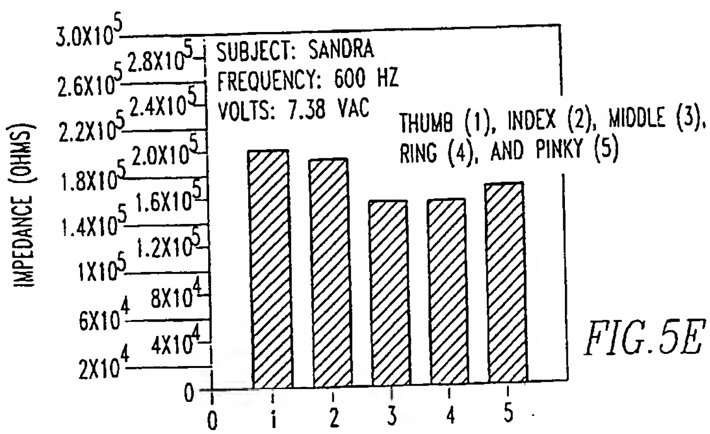


FIG.5E

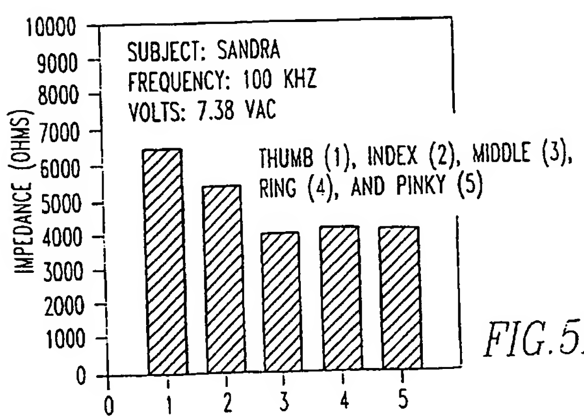


FIG.5F

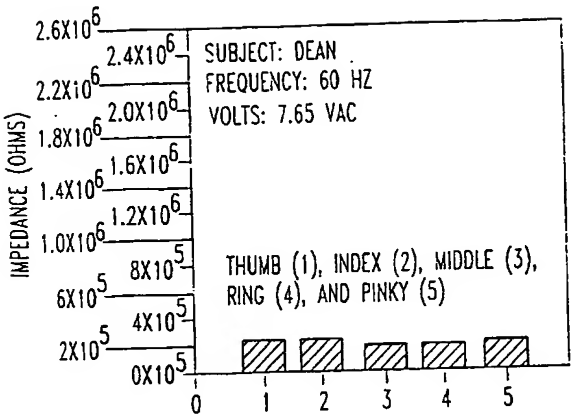


FIG.6A

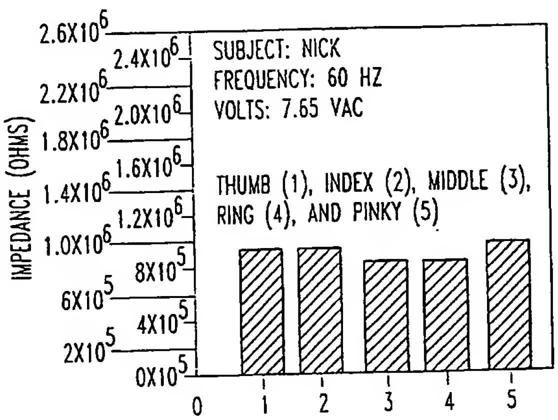


FIG.6B

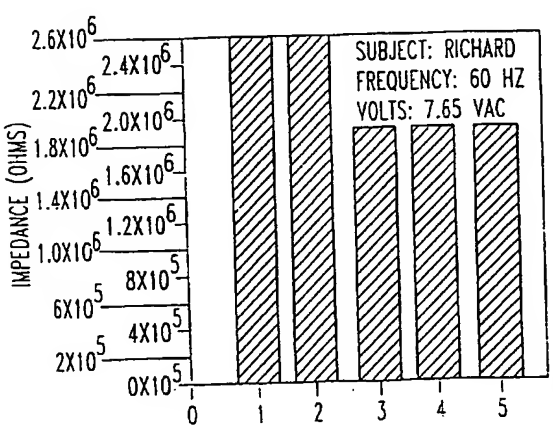


FIG.6C

THUMB (1), INDEX (2), MIDDLE (3), RING (4), AND PINKY (5)

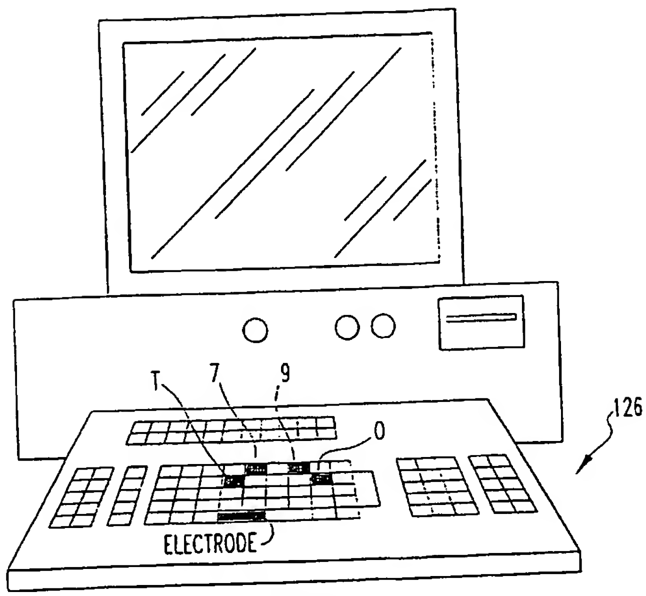


FIG.7

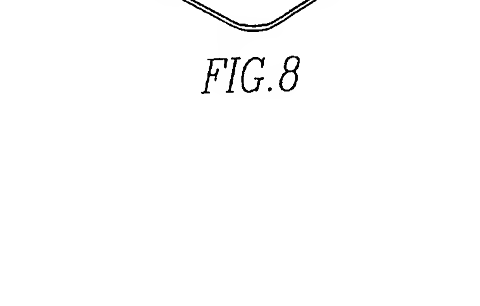


FIG.8

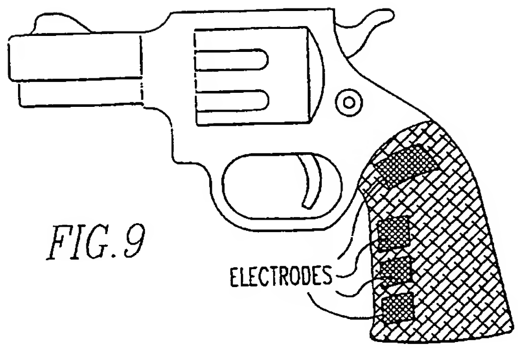


FIG.9

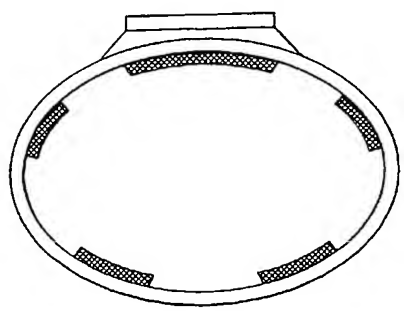


FIG10

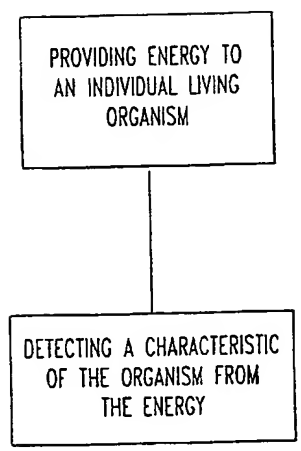

PROVIDING ENERGY TO AN INDIVIDUAL LIVING ORGANISM
DETECTING A CHARACTERISTIC OF THE ORGANISM FROM THE ENERGY

FIG.11

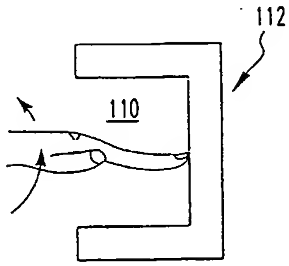


FIG.12a

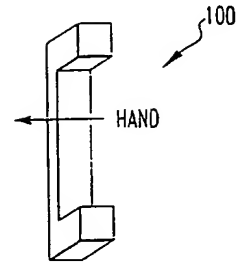


FIG.12b

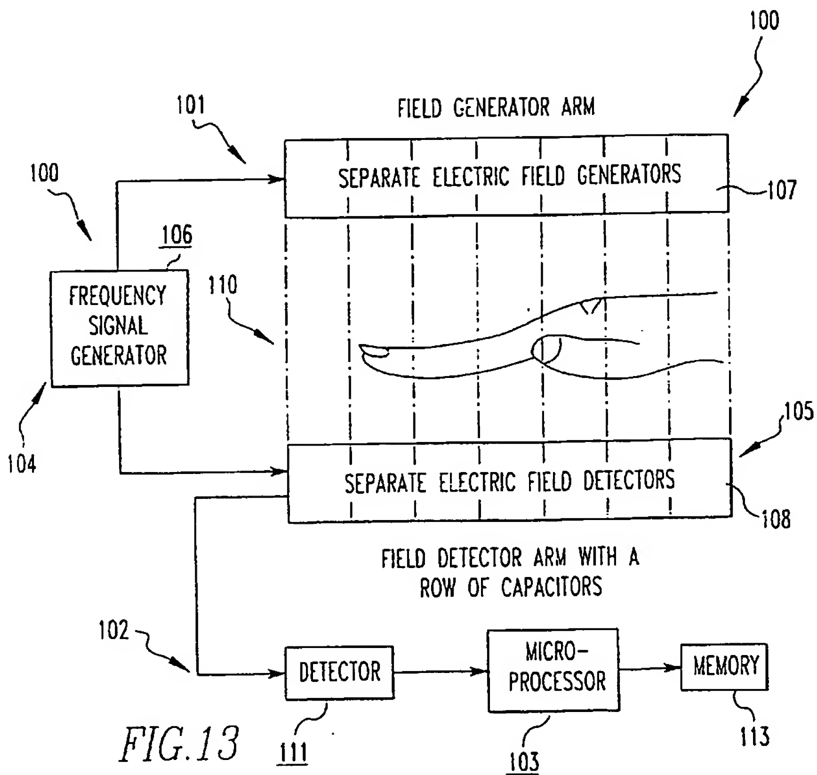
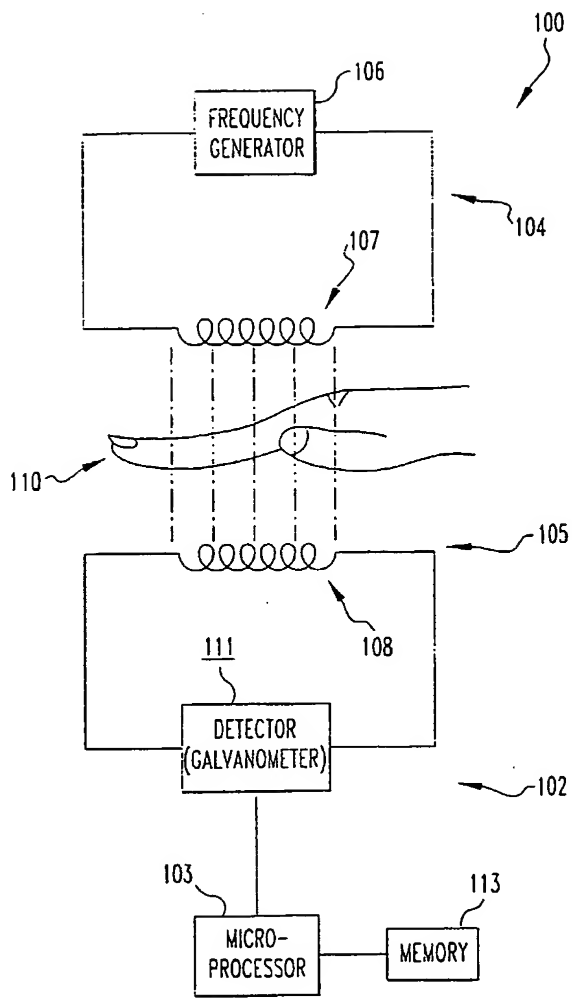


FIG.13



DETECTOR CAN BE A PHASE SENSITIVE DETECTOR

FIG.14

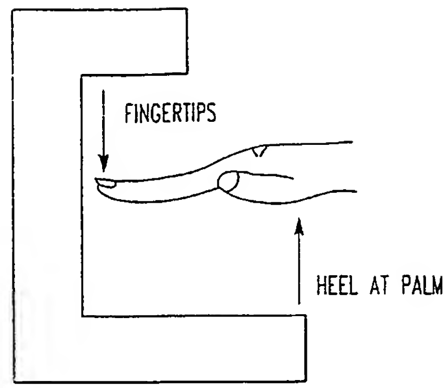

FINGERTIPS
HEEL AT PALM

FIG.15

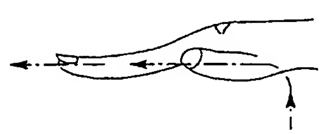
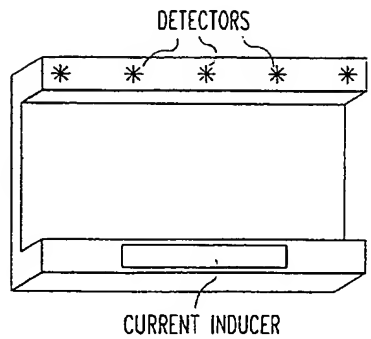
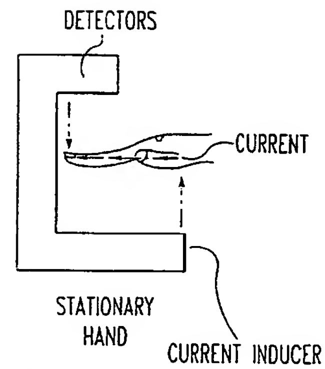

CURRENT
FROM HEEL OF PALM
LENGTHWISE TO FINGERTIPS

FIG.16



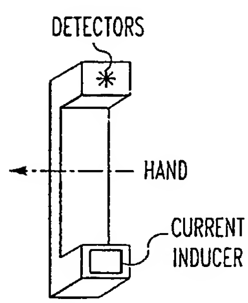
STATIONARY HAND

FIG.17a



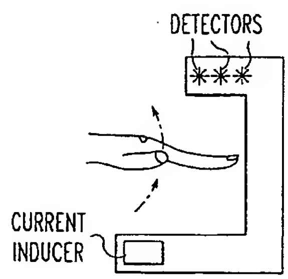
STATIONARY HAND

FIG.17b



MOVING HAND

FIG.18a



MOVING HAND

FIG.18b

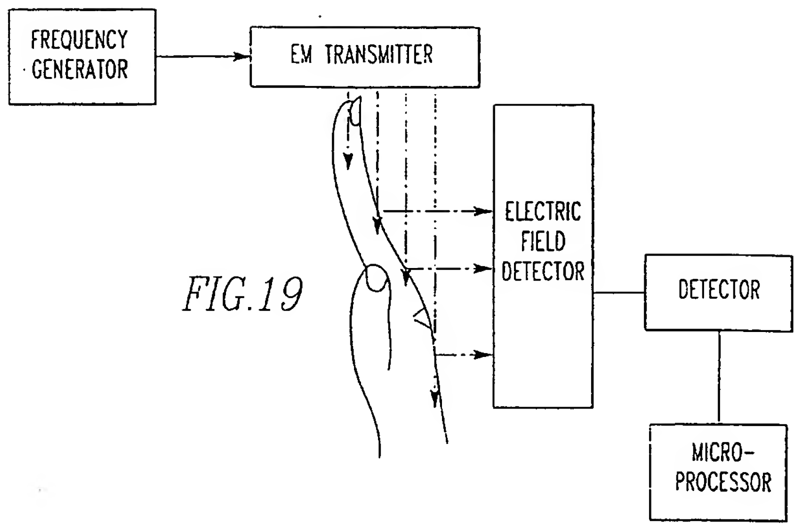

FREQUENCY GENERATOR
EM TRANSMITTER
ELECTRIC FIELD DETECTOR
DETECTOR
MICRO-PROCESSOR

FIG.19

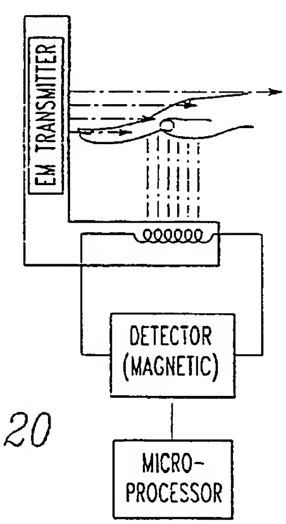

EM TRANSMITTER
DETECTOR (MAGNETIC)
MICRO-PROCESSOR

FIG.20

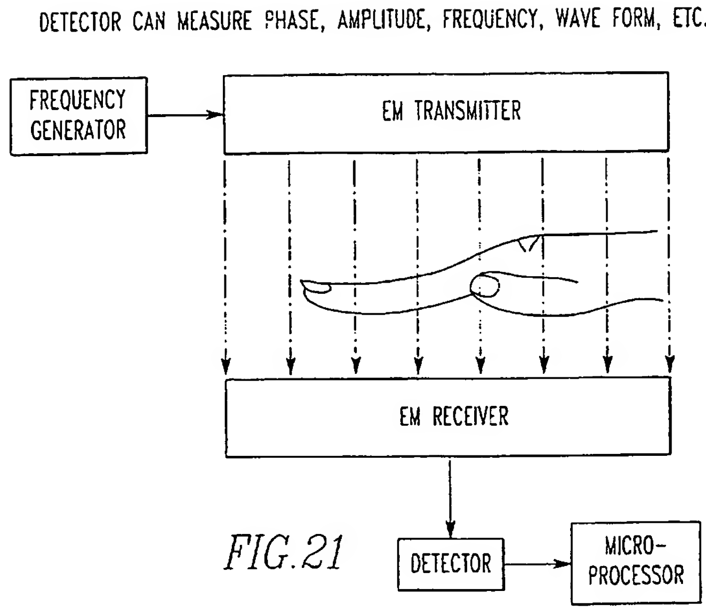

DETECTOR CAN MEASURE PHASE, AMPLITUDE, FREQUENCY, WAVE FORM, ETC.
FREQUENCY GENERATOR
EM TRANSMITTER
EM RECEIVER
DETECTOR
MICRO-PROCESSOR

FIG.21

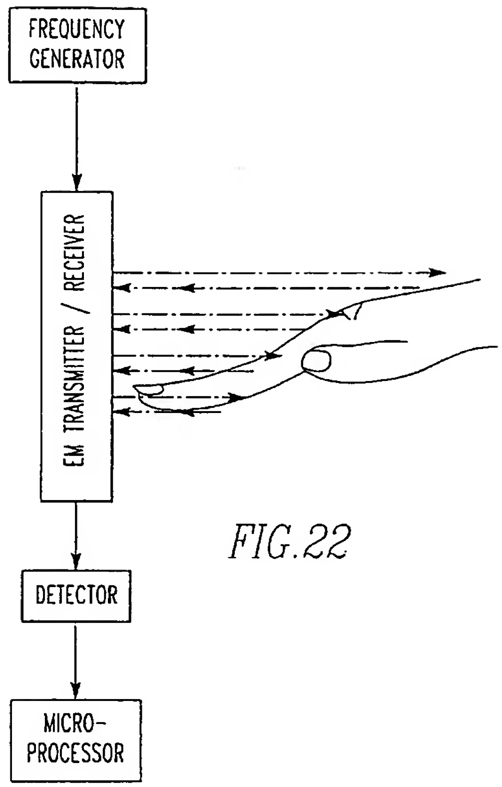

FREQUENCY GENERATOR
EM TRANSMITTER / RECEIVER
DETECTOR
MICRO-PROCESSOR

FIG.22

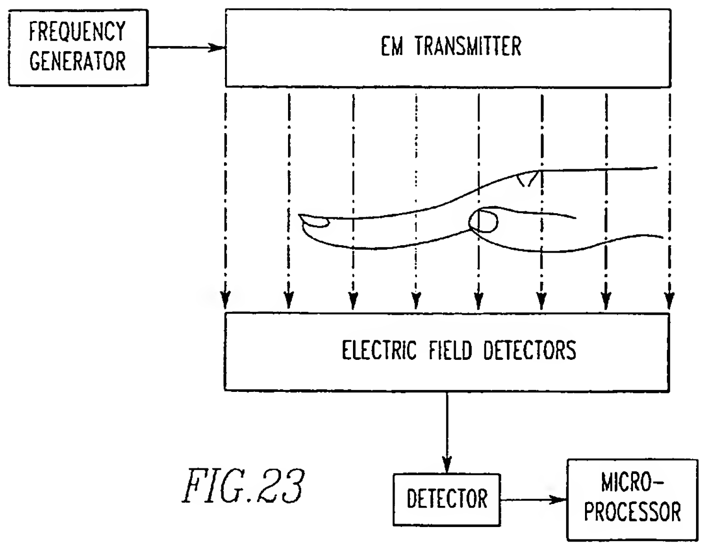
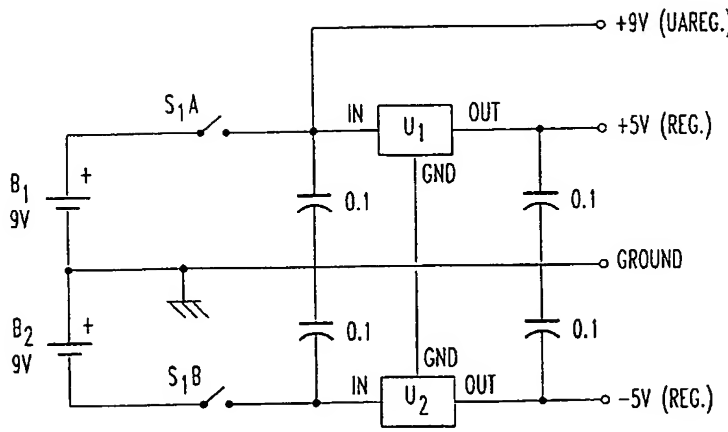

FREQUENCY GENERATOR
EM TRANSMITTER
ELECTRIC FIELD DETECTORS
DETECTOR
MICRO-PROCESSOR

FIG.23



U_1= 78LOSACLP POSITIVE 5 VOLT REGULATOR
U_2= 79LOSCLP NEGATIVE 5 VOLT REGULATOR
S_1= DPST

POWER SUPPLY REGULATORS

FIG.24

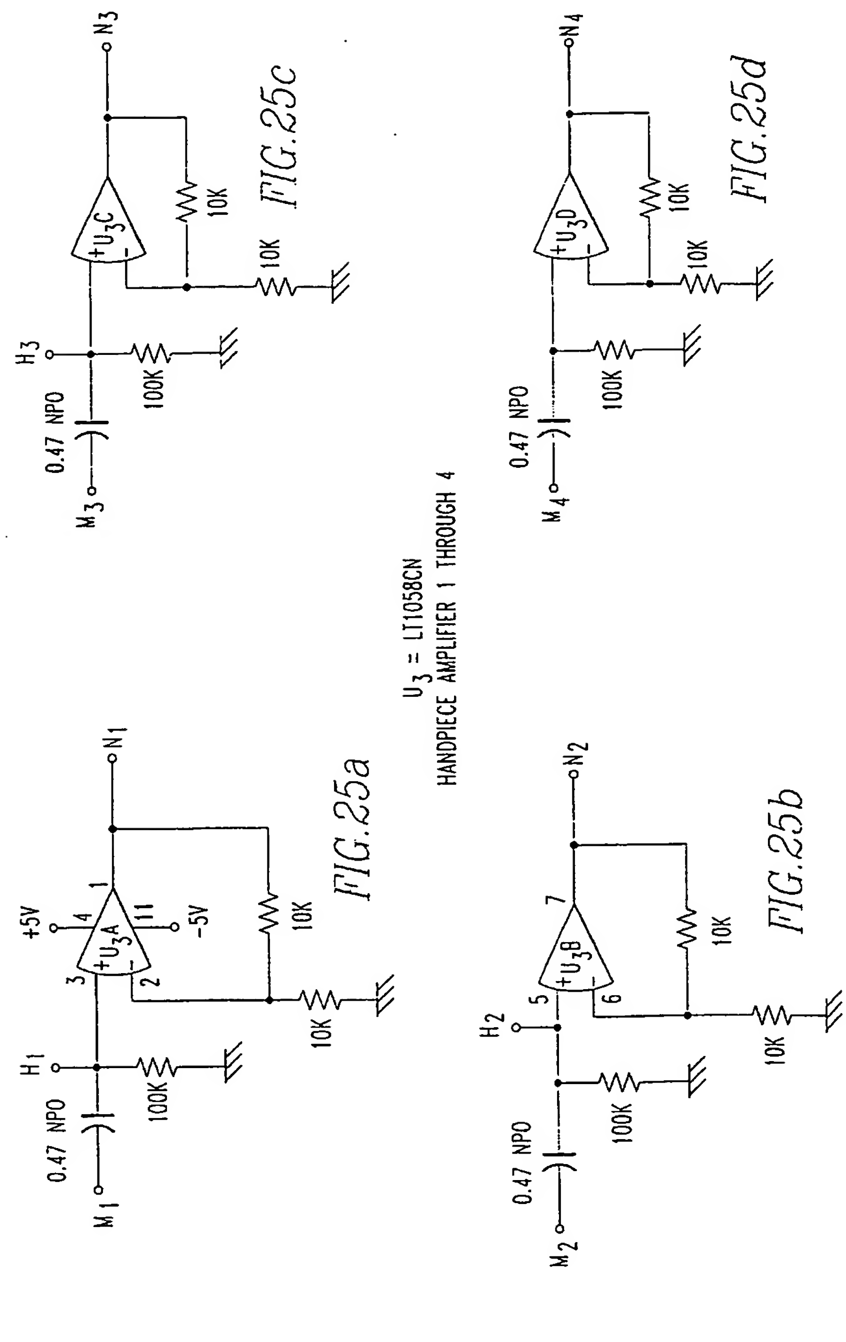


FIG.25a FIG.25b FIG.25c FIG.25d

U_3 = LT1058CN
HANDPIECE AMPLIFIER 1 THROUGH 4

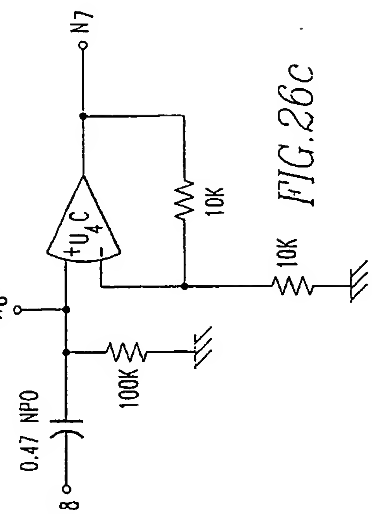


FIG.26c

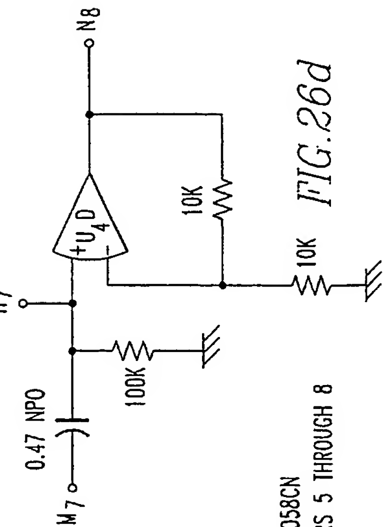


FIG.26d

U4 = LT1058CN
HANDPIECE AMPLIFIERS 5 THROUGH 8

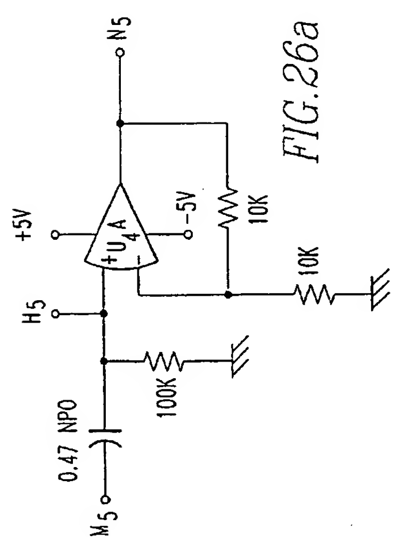


FIG.26a

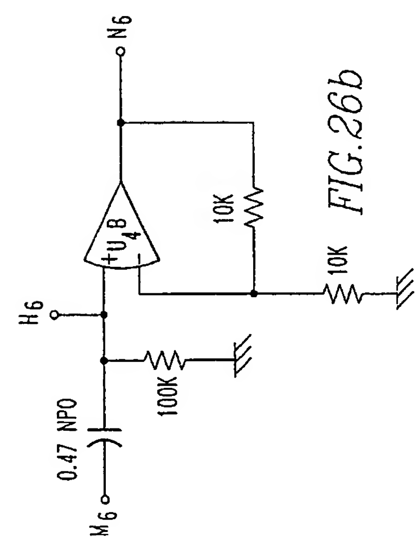


FIG.26b

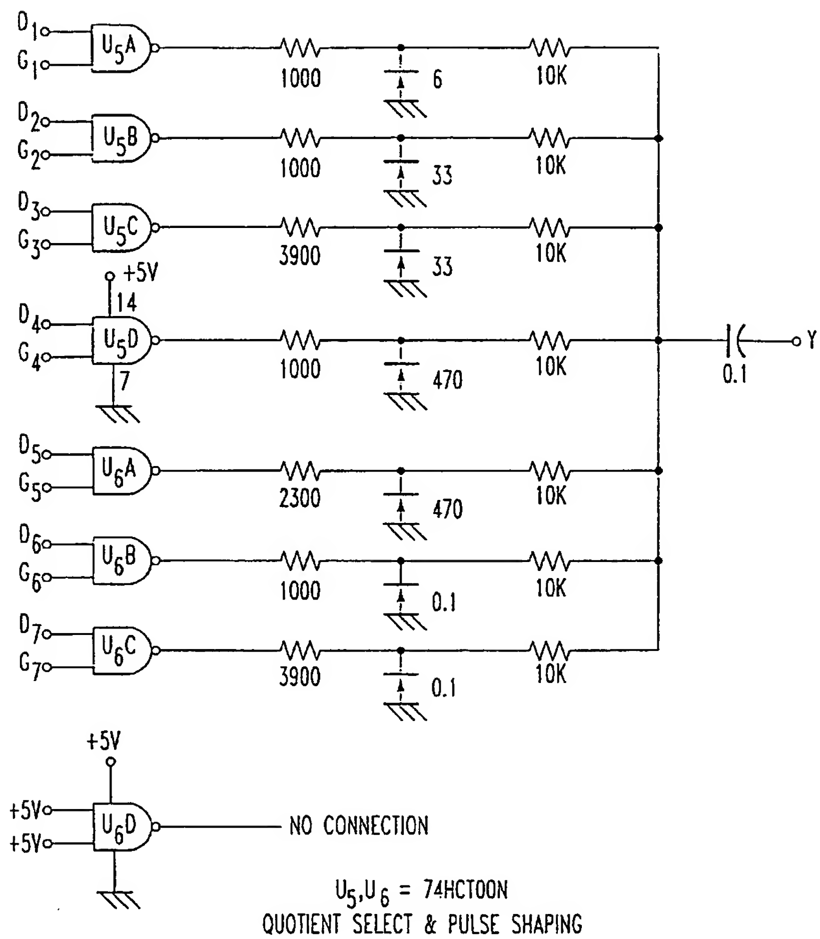

D1
G1
U5A
1000
6
10K
D2
G2
U5B
1000
33
10K
D3
G3
U5C
3900
33
10K
+5V
14
D4
G4
U5D
7
1000
470
10K
0.1
Y
D5
G5
U6A
2300
470
10K
D6
G6
U6B
1000
0.1
10K
D7
G7
U6C
3900
0.1
10K
+5V
+5V
+5V
U6D
NO CONNECTION
U5,U6 = 74HCT00N
QUOTIENT SELECT & PULSE SHAPING

FIG.27

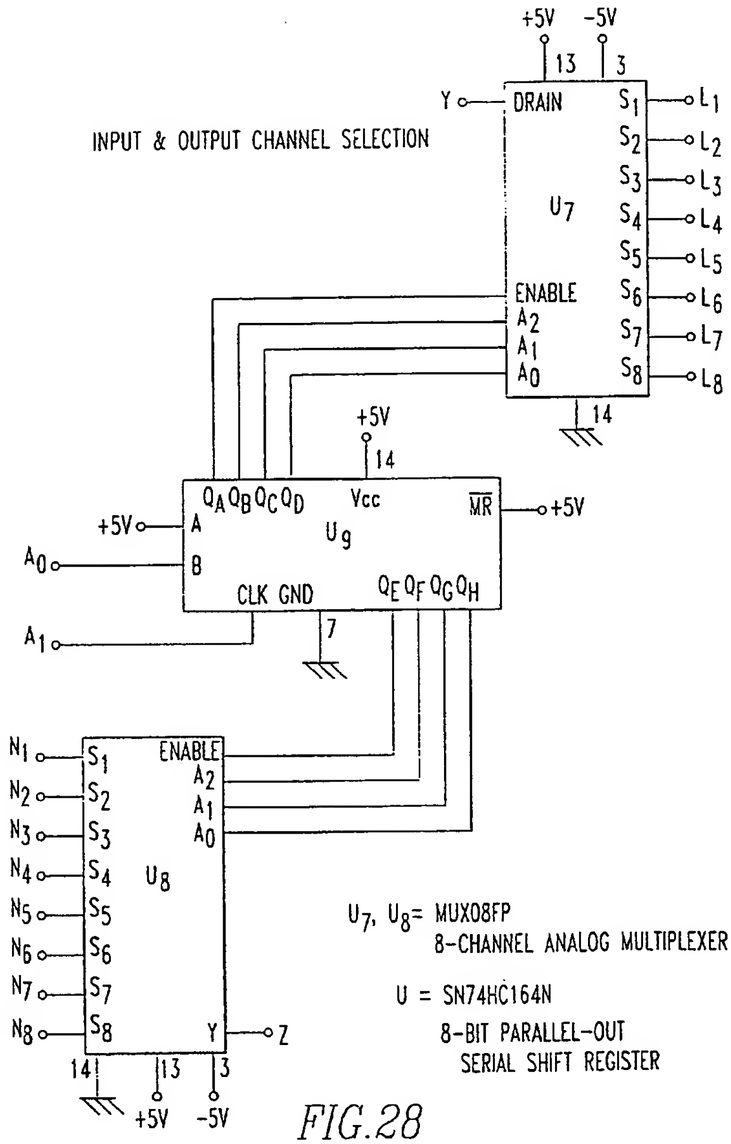
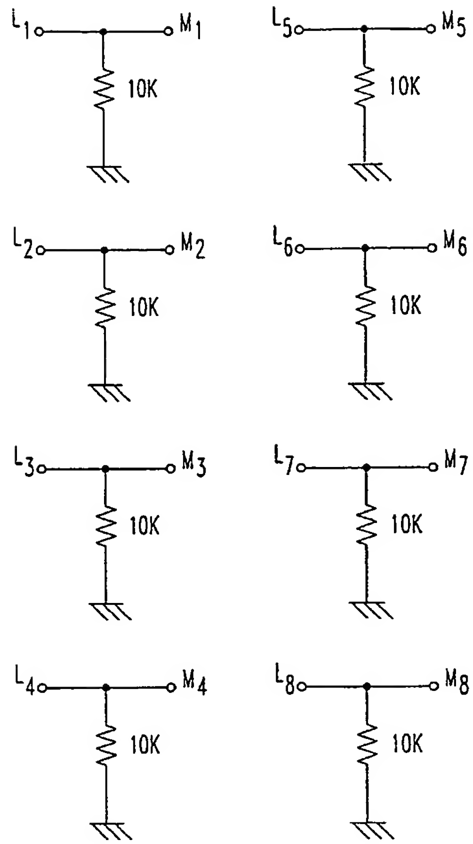

+5V
-5V
13
3
Y
DRAIN
INPUT & OUTPUT CHANNEL SELECTION
S_1 L_1
S_2 L_2
S_3 L_3
U_7
S_4 L_4
S_5 L_5
ENABLE
S_6 L_6
A_2
S_7 L_7
A_1
A_0
S_8 L_8
14
+5V
14
Q_A Q_B Q_C Q_D
Vcc
$\overline{MR}$
+5V
+5V
A
U_9
A_0
B
CLK GND
Q_E Q_F Q_G Q_H
A_1
7
N_1 S_1
ENABLE
N_2 S_2
A_2
A_1
N_3 S_3
A_0
N_4 S_4
U_8
N_5 S_5
N_6 S_6
N_7 S_7
N_8 S_8
Y
Z
14
13
3
+5V
-5V
U_7, U_8= MUX08FP
8-CHANNEL ANALOG MULTIPLEXER
U = SN74HC164N
8-BIT PARALLEL-OUT
SERIAL SHIFT REGISTER

FIG.28



OUTPUT MUX LOAD RESISTORS

FIG.29

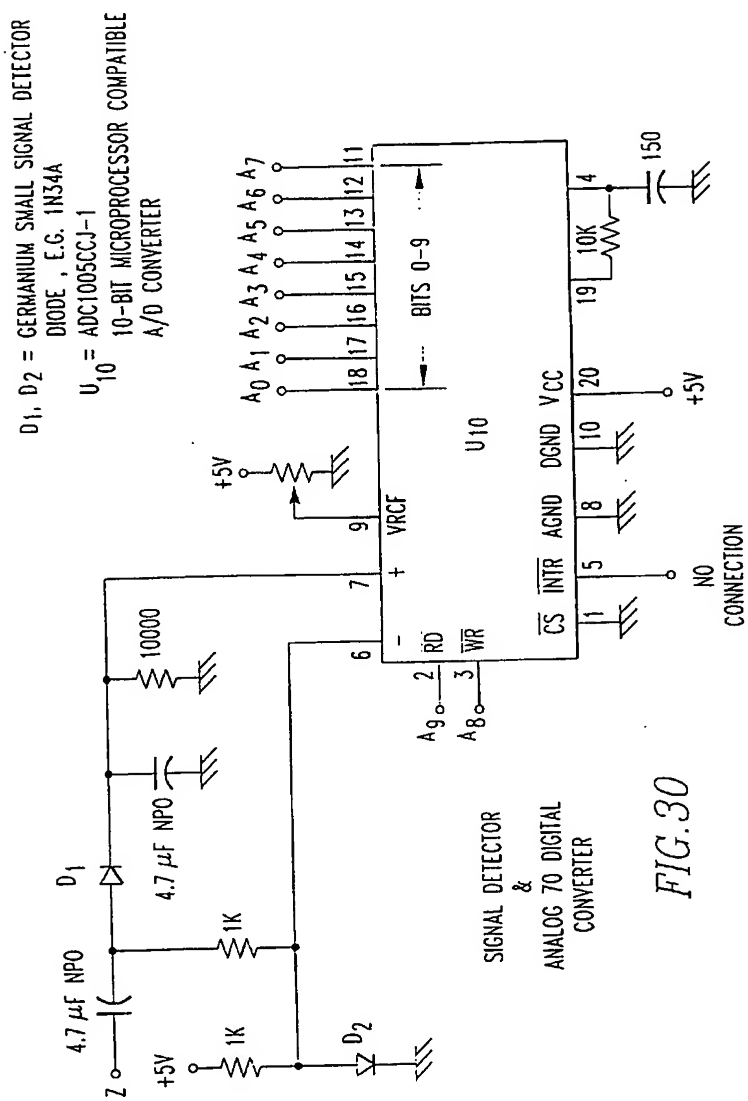

D_1, D_2 = GERMANIUM SMALL SIGNAL DETECTOR DIODE , E.G. 1N34A
U_{10} = ADC1005CCJ-1 10-BIT MICROPROCESSOR COMPATIBLE A/D CONVERTER
A_0 A_1 A_2 A_3 A_4 A_5 A_6 A_7
BITS 0-9
U_{10}
+5V
VRCF
VCC
DGND
AGND
$\overline{INTR}$
$\overline{CS}$
$\overline{RD}$
$\overline{WR}$
A_9
A_8
10K
150
NO CONNECTION
10000
4.7 μF NPO
D_1
D_2
1K
Z
SIGNAL DETECTOR & ANALOG TO DIGITAL CONVERTER

FIG.30

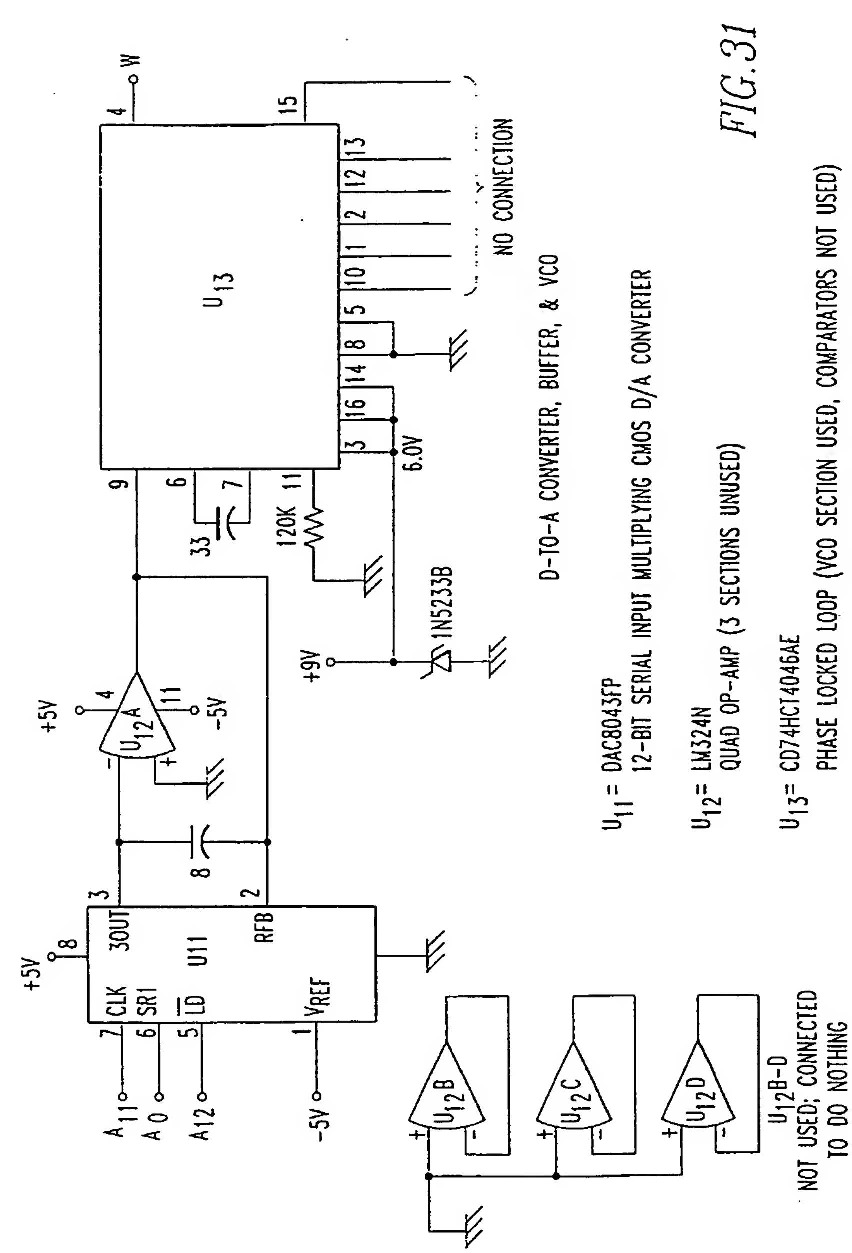
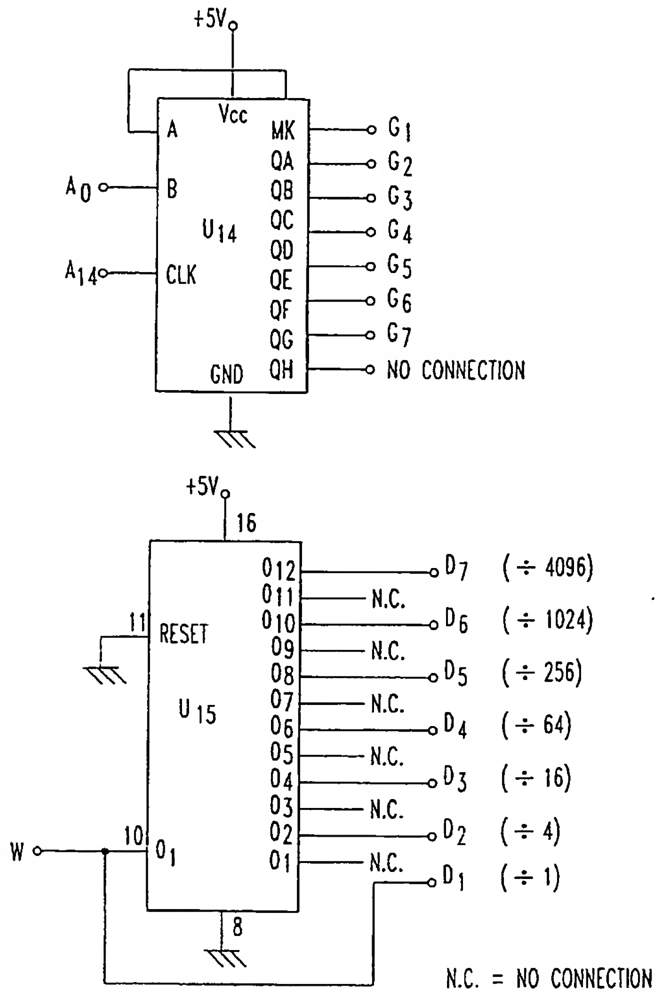

+5V
8
CLK
SR1
LD
VREF
3OUT
U11
RFB
7
6
5
1
3
2
A11
A0
A12
-5V
8
+5V
4
U12A
11
-5V
+9V
1N5233B
120K
33
9
6
7
11
6.0V
U13
4
W
15
3
16
14
8
5
10
1
2
12
13
NO CONNECTION
U12B
U12C
U12D
U12B-D
NOT USED; CONNECTED
TO DO NOTHING
D-TO-A CONVERTER, BUFFER, & VCO
U11= DAC8043FP
12-BIT SERIAL INPUT MULTIPLYING CMOS D/A CONVERTER
U12= LM324N
QUAD OP-AMP (3 SECTIONS UNUSED)
U13= CD74HCT4046AE
PHASE LOCKED LOOP (VCO SECTION USED, COMPARATORS NOT USED)

FIG.31

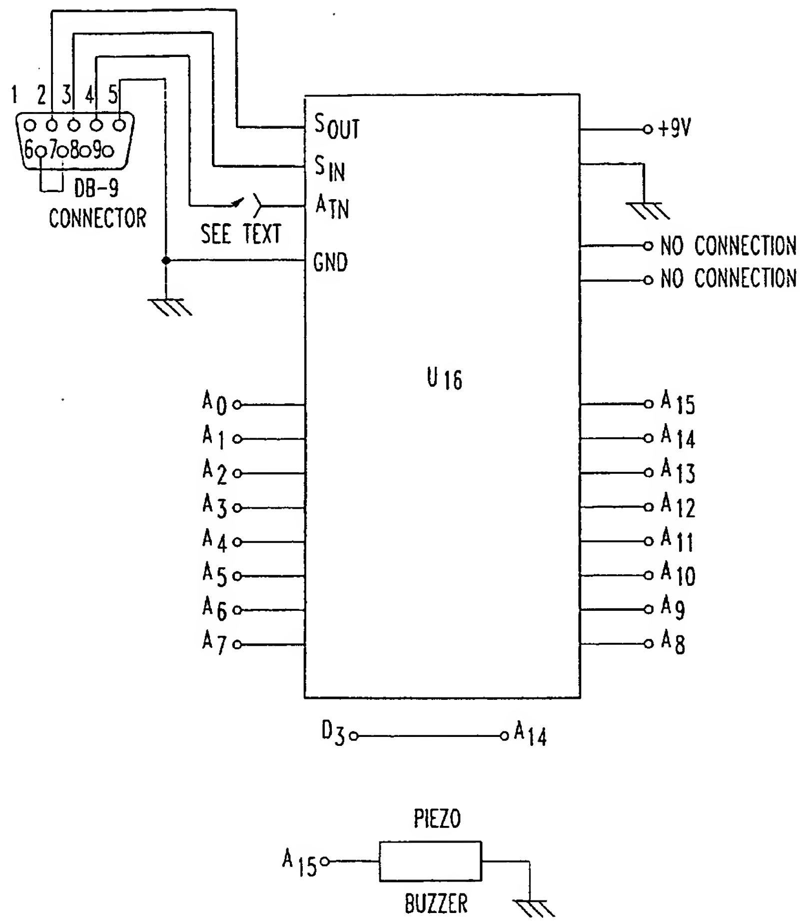
FREQUENCY DIVIDER & FREQUENCY DIVIDER
GATE SHIFT REGISTER



U_{14} = SN74HC164N
8-BIT PARALLEL-OUT SERIAL SHIFT REGISTER

U_{15} = 74HC4040
12-STAGE RIPPLE CARRY BINARY COUNTER

FIG. 32



MICROPROCESSOR
U_{16}= PARALLAX, INC. BASIC STAMP II
MICROCONTROLLER W/2048-BYTE EEPROM,
26 BYTE RAM, 16 1/0 LINES & SERIAL INTERFACE.

FIG. 33

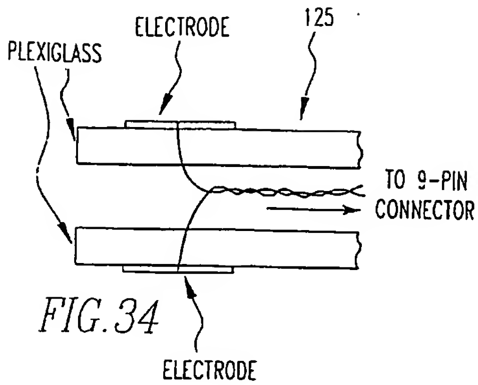


FIG. 34

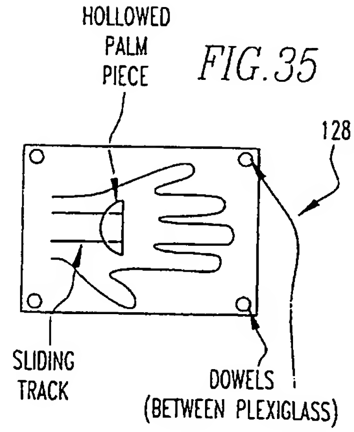


FIG. 35

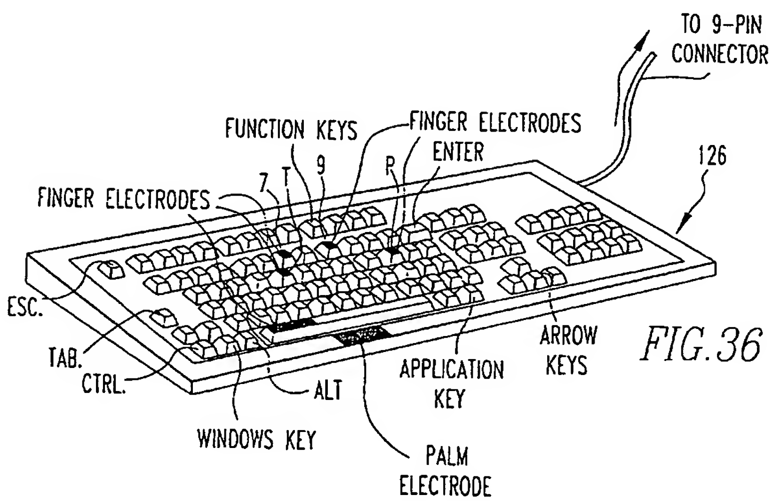


FIG. 36

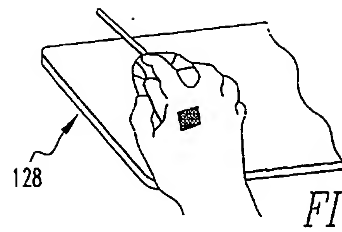


FIG.37

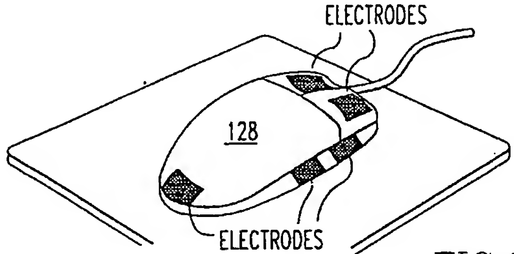


FIG.38

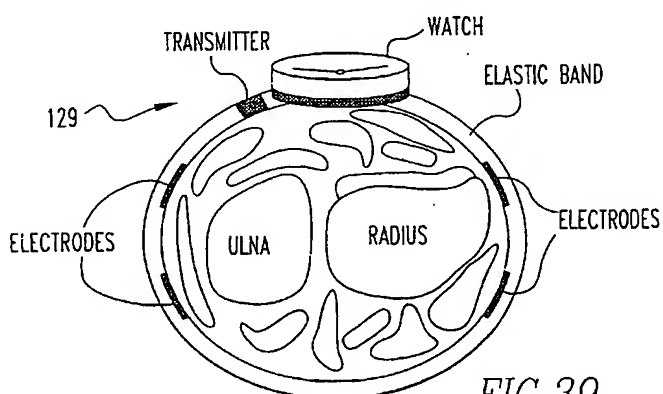


FIG.39

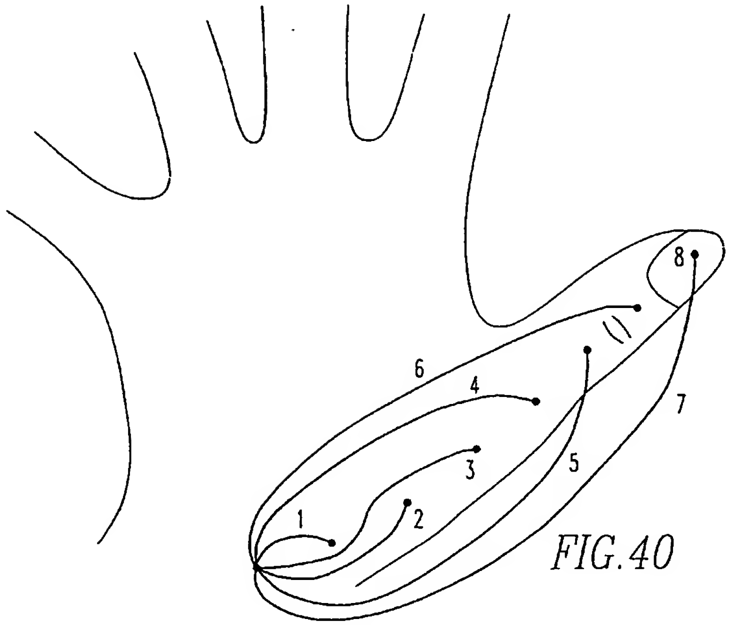


FIG.40

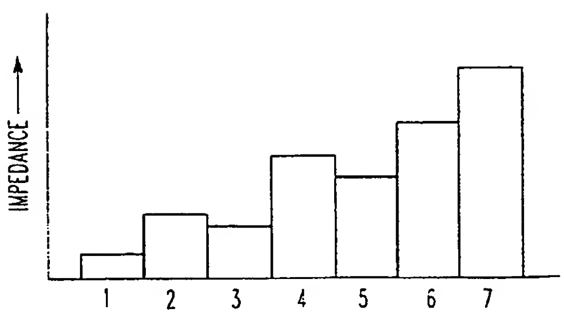


FIG.41

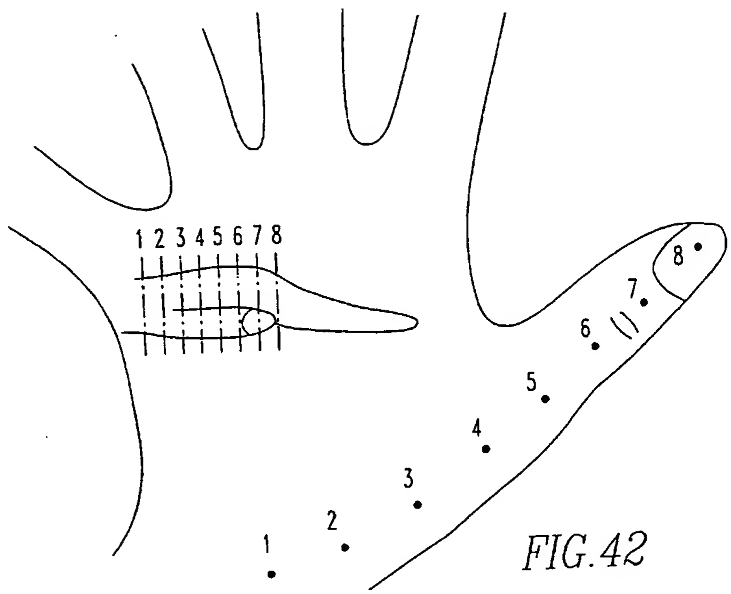


FIG.42

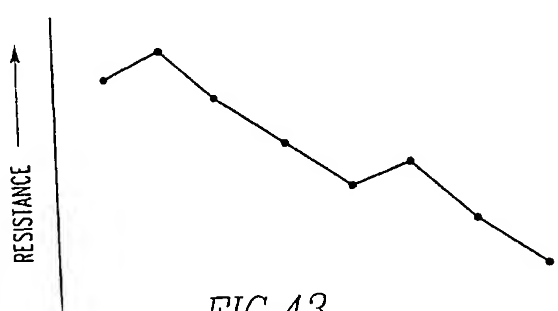


FIG.43

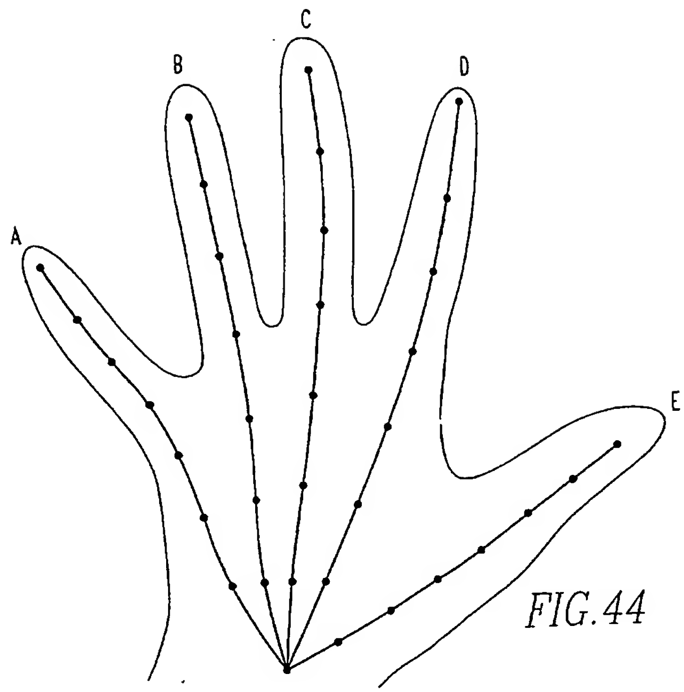

A
B
C
D
E

FIG.44

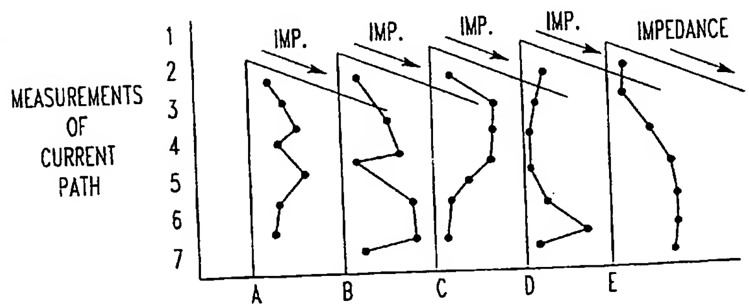

MEASUREMENTS OF CURRENT PATH
1
2
3
4
5
6
7
IMP.
IMP.
IMP.
IMP.
IMPEDANCE
A
B
C
D
E

FIG.45

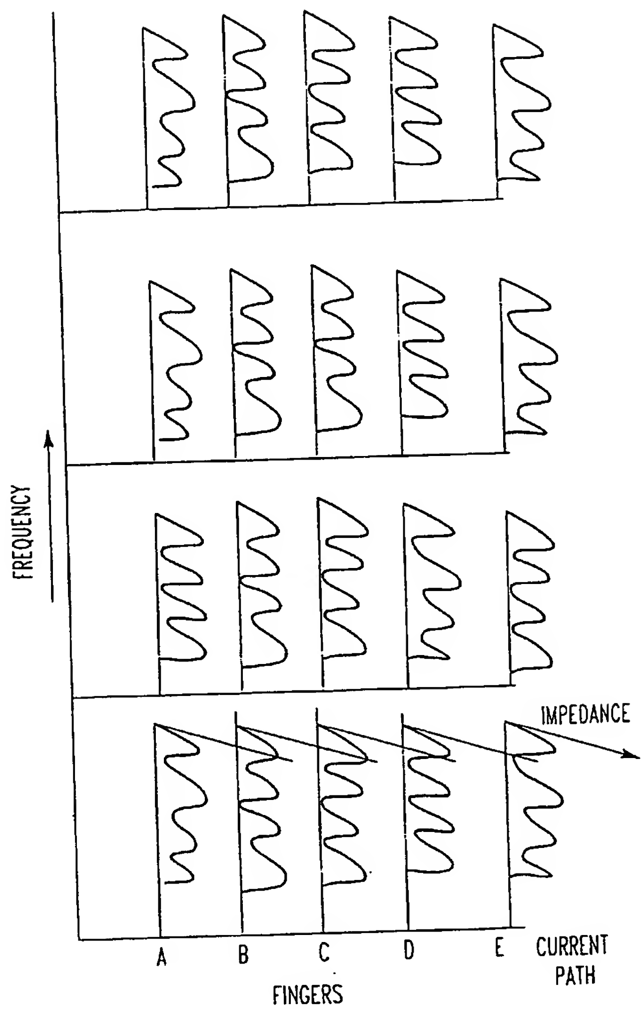


FIG.46

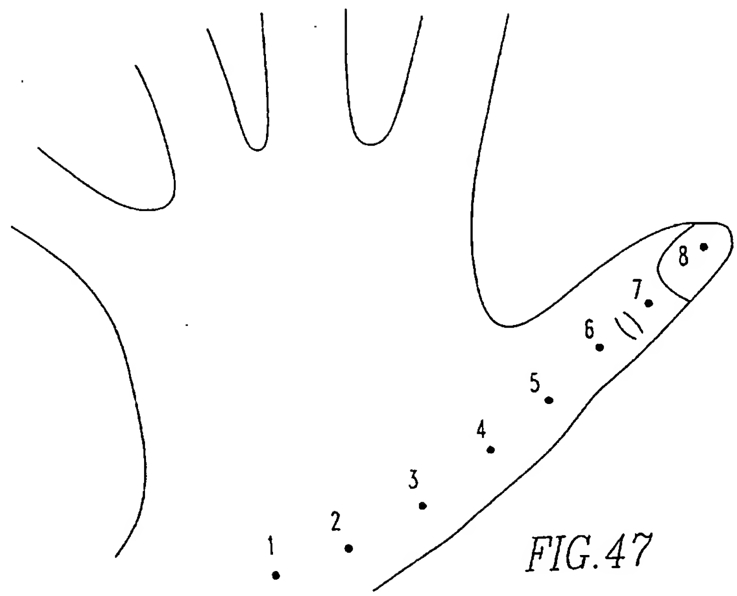

1
2
3
4
5
6
7
8

FIG.47

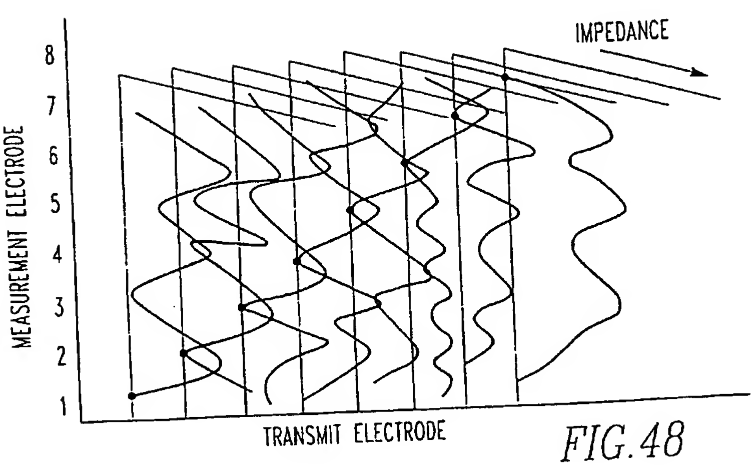

IMPEDANCE
MEASUREMENT ELECTRODE
8
7
6
5
4
3
2
1
TRANSMIT ELECTRODE

FIG.48

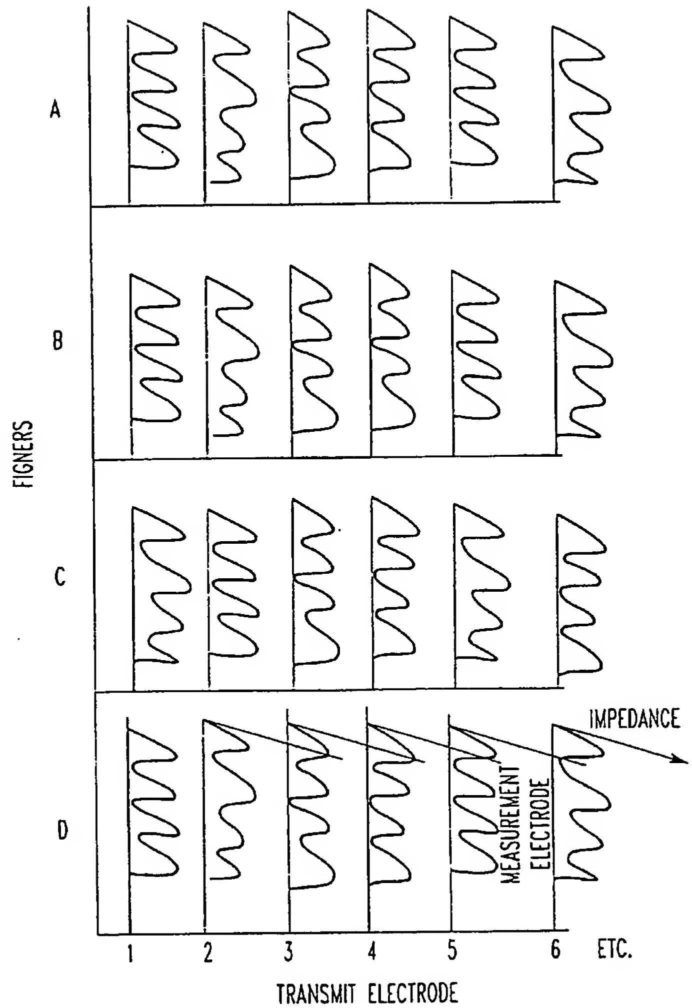

A
B
C
D
FIGNERS
IMPEDANCE
MEASUREMENT ELECTRODE
1
2
3
4
5
6
ETC.
TRANSMIT ELECTRODE

FIG. 49

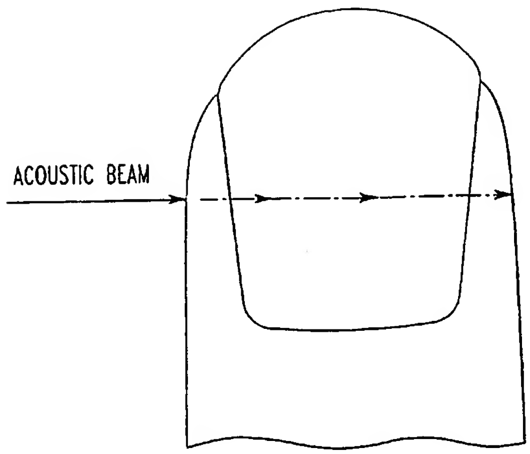


FIG.50

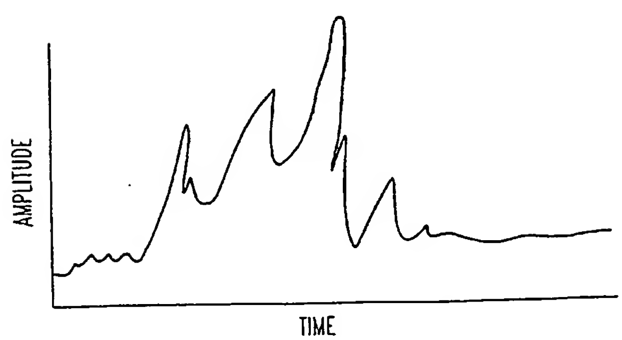


FIG.51

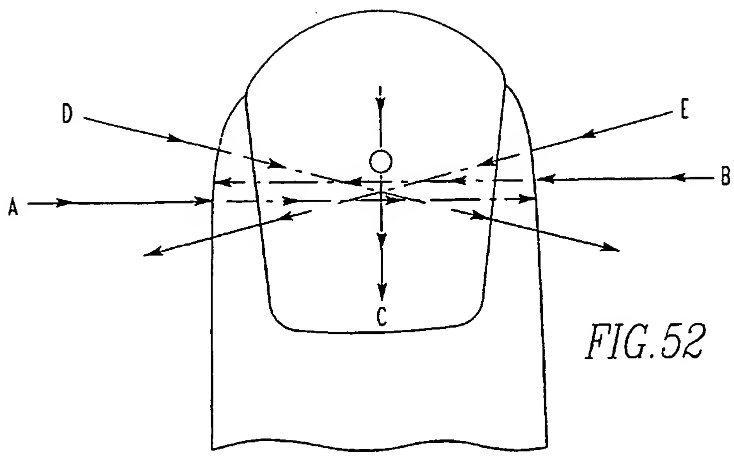


FIG.52

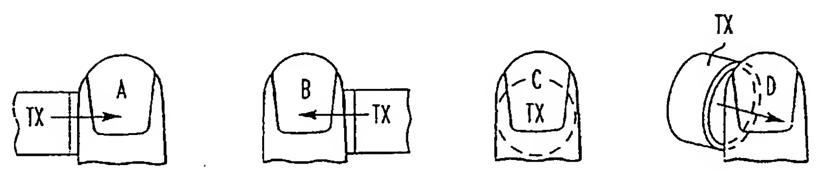


FIG.52a FIG.52b FIG.52c FIG.52d

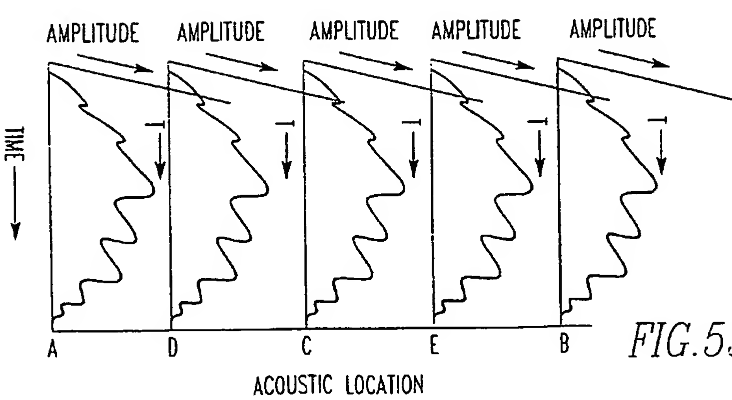


FIG.53

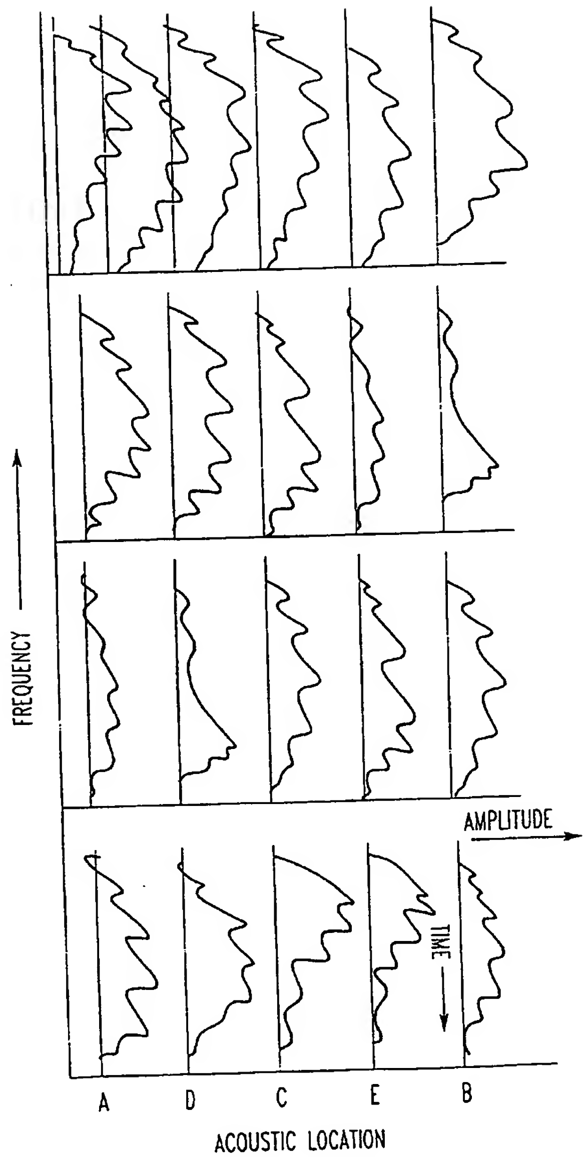


FIG.54

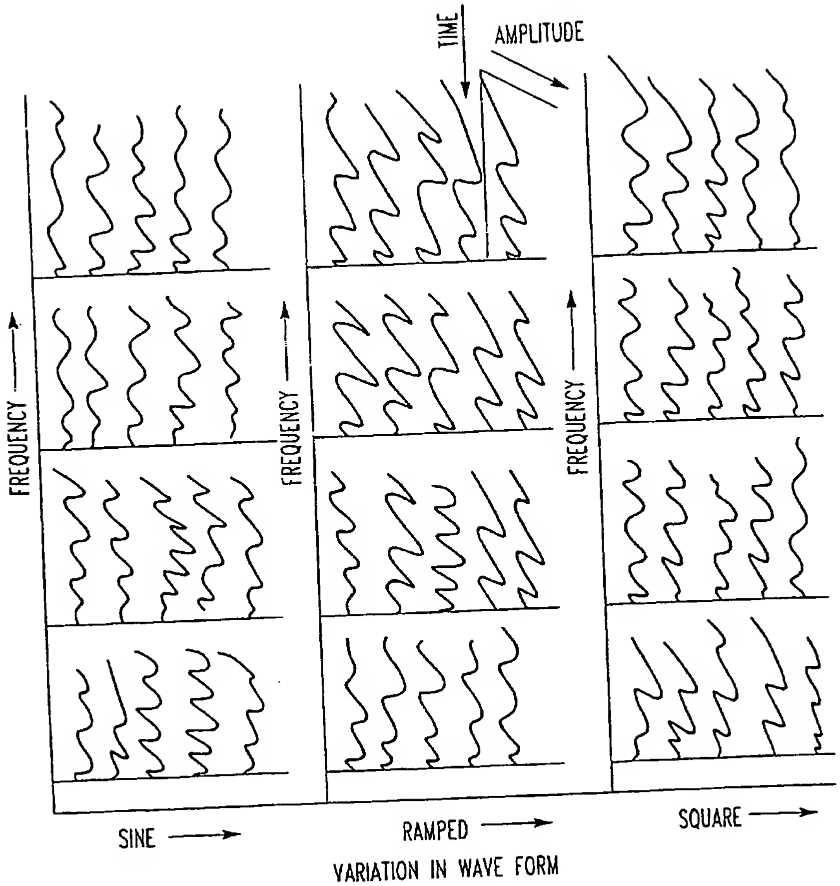

TIME
AMPLITUDE
FREQUENCY
FREQUENCY
FREQUENCY
SINE
RAMPED
SQUARE
VARIATION IN WAVE FORM

FIG.55

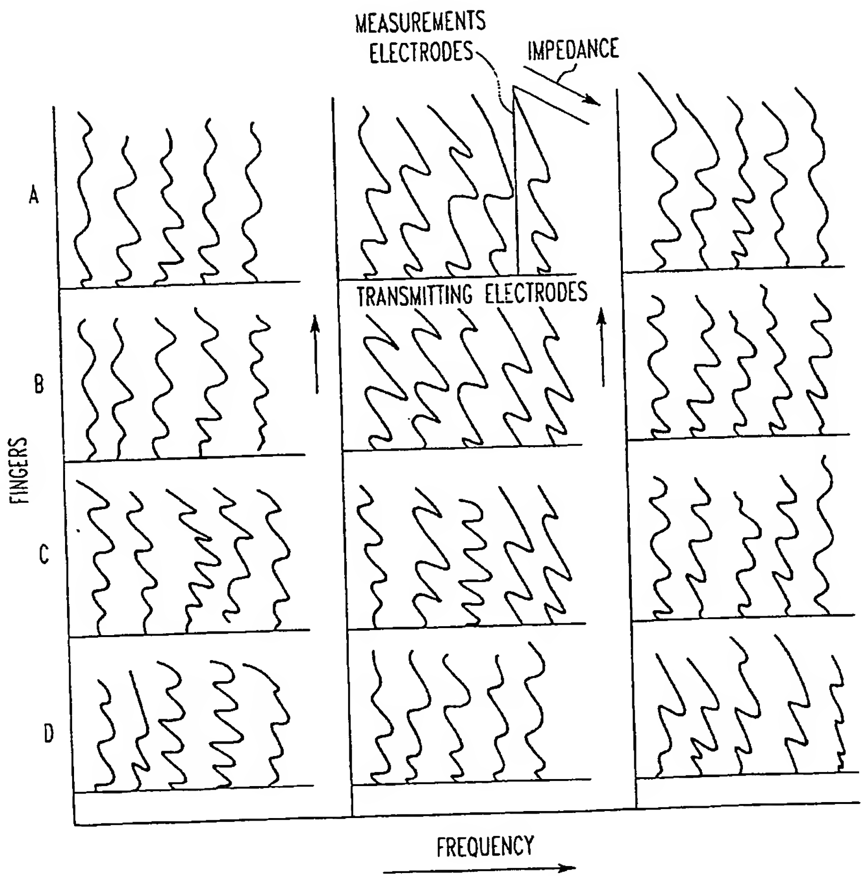

MEASUREMENTS
ELECTRODES
IMPEDANCE
TRANSMITTING ELECTRODES
A
B
C
D
FINGERS
FREQUENCY

FIG.56

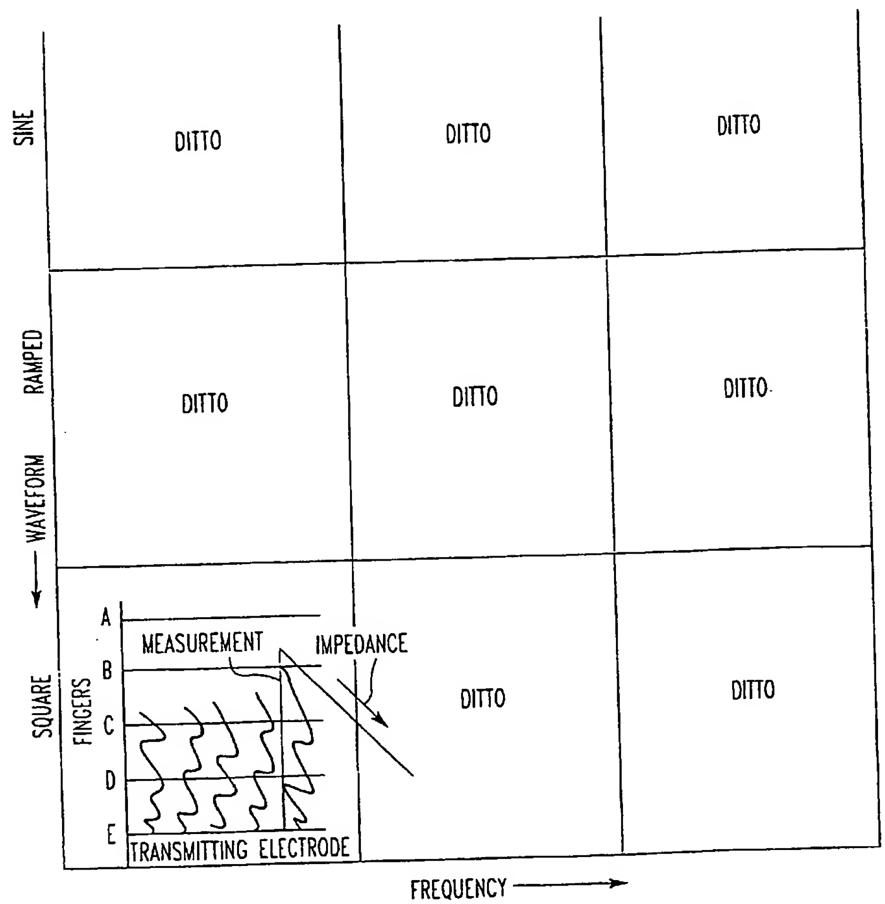

SINE
RAMPED
WAVEFORM
SQUARE
DITTO
DITTO
DITTO
DITTO
DITTO
DITTO
DITTO
DITTO
FINGERS
A
B
C
D
E
MEASUREMENT
IMPEDANCE
TRANSMITTING ELECTRODE
FREQUENCY

FIG.57

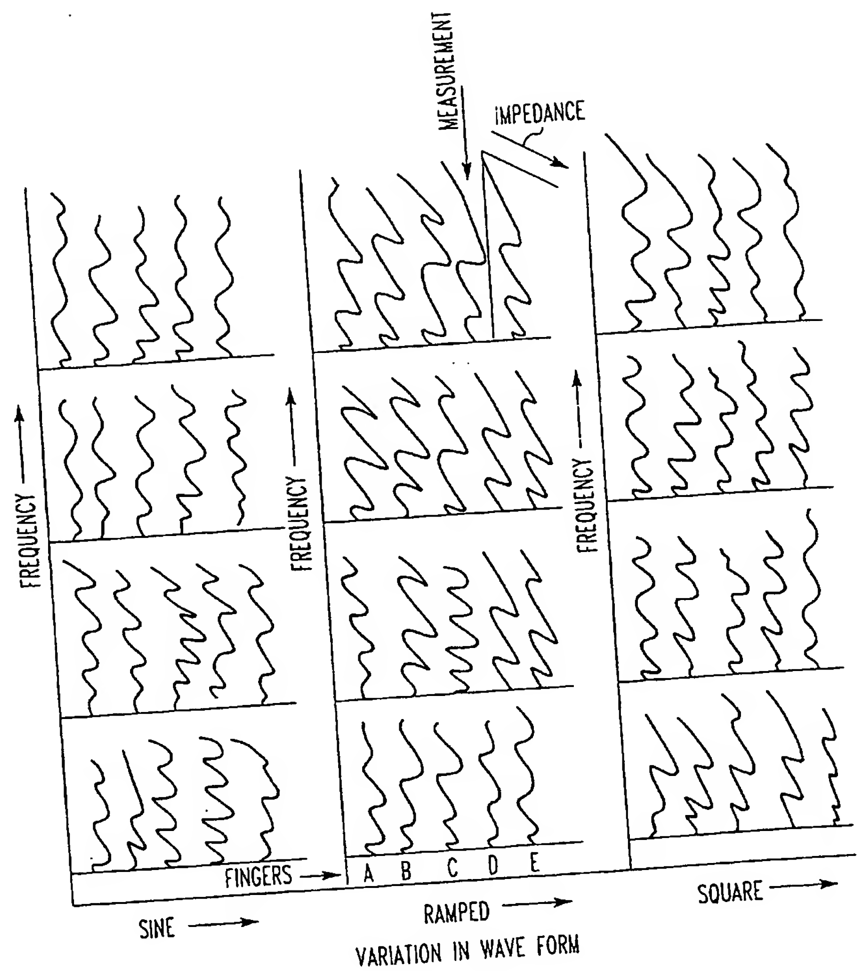

MEASUREMENT
IMPEDANCE
FREQUENCY
FREQUENCY
FREQUENCY
FINGERS
A B C D E
SINE
RAMPED
SQUARE
VARIATION IN WAVE FORM

FIG.58

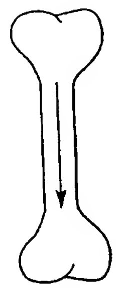


FIG.59

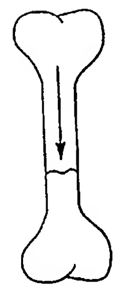


FIG.60

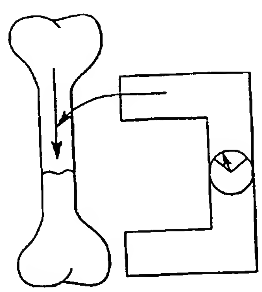


FIG.61

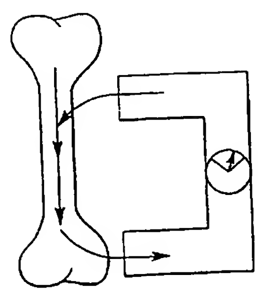


FIG.62

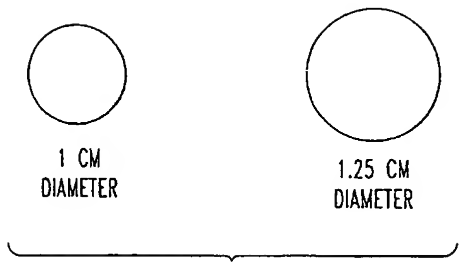

1 CM
DIAMETER
1.25 CM
DIAMETER

FIG.63

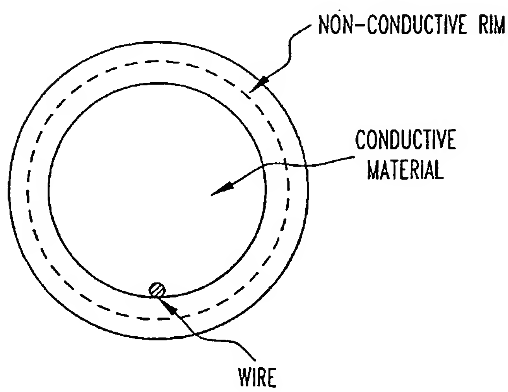
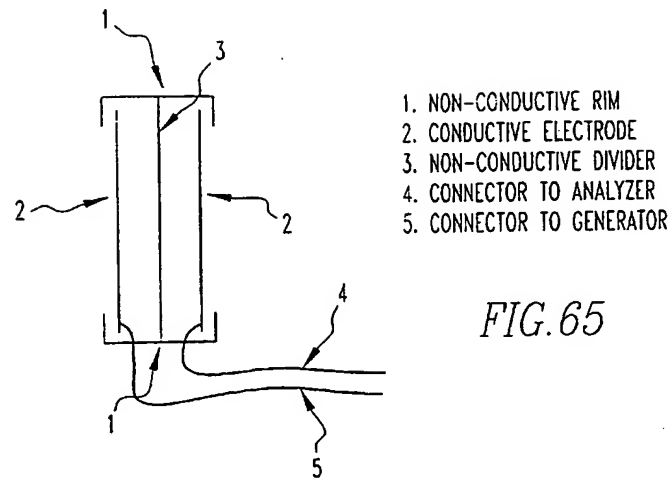
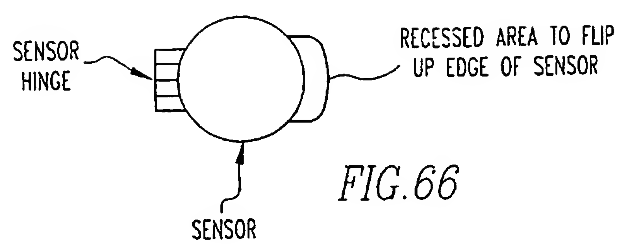

NON-CONDUCTIVE RIM
CONDUCTIVE
MATERIAL
WIRE

FIG.64



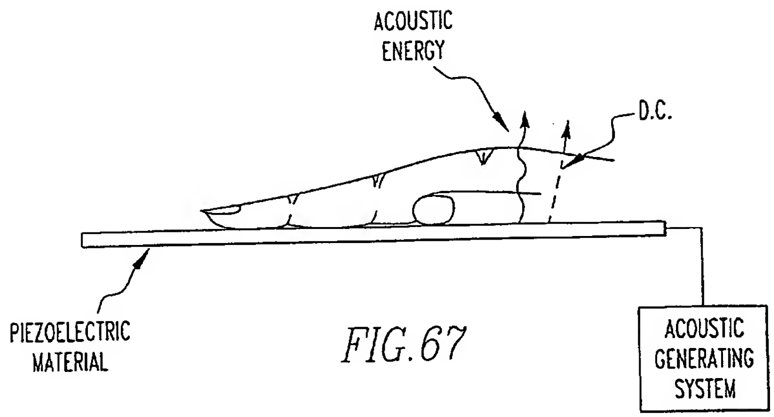
1
3
2
2
4
1
5
1. NON-CONDUCTIVE RIM
2. CONDUCTIVE ELECTRODE
3. NON-CONDUCTIVE DIVIDER
4. CONNECTOR TO ANALYZER
5. CONNECTOR TO GENERATOR

FIG. 65



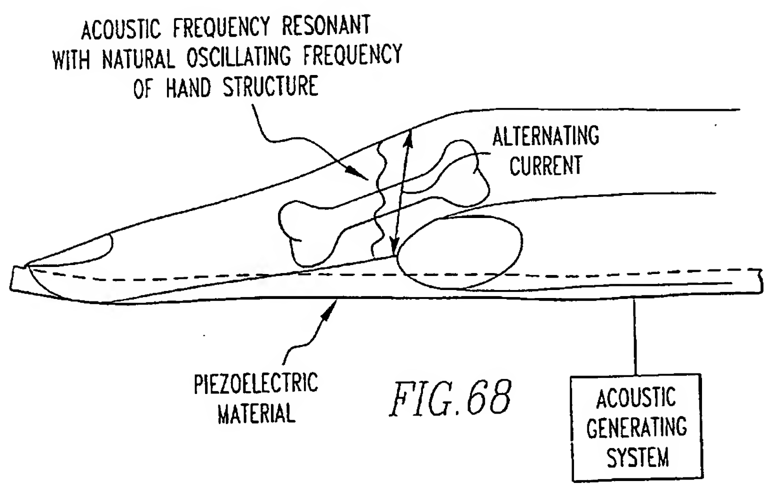
SENSOR HINGE
RECESSED AREA TO FLIP UP EDGE OF SENSOR
SENSOR

FIG. 66



ACOUSTIC
ENERGY
D.C.
PIEZOELECTRIC
MATERIAL
ACOUSTIC
GENERATING
SYSTEM

FIG. 67



ACOUSTIC FREQUENCY RESONANT
WITH NATURAL OSCILLATING FREQUENCY
OF HAND STRUCTURE
ALTERNATING
CURRENT
PIEZOELECTRIC
MATERIAL
ACOUSTIC
GENERATING
SYSTEM

FIG. 68

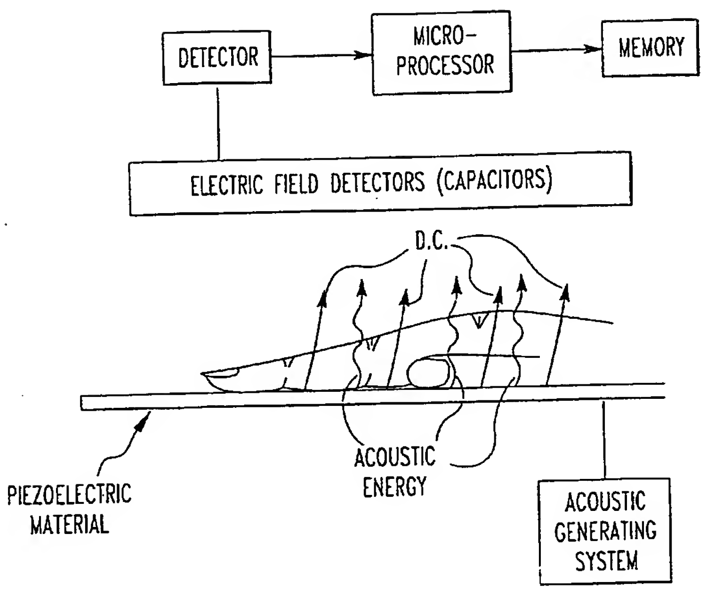

DETECTOR
MICRO-
PROCESSOR
MEMORY
ELECTRIC FIELD DETECTORS (CAPACITORS)
D.C.
ACOUSTIC
ENERGY
PIEZOELECTRIC
MATERIAL
ACOUSTIC
GENERATING
SYSTEM

FIG.69

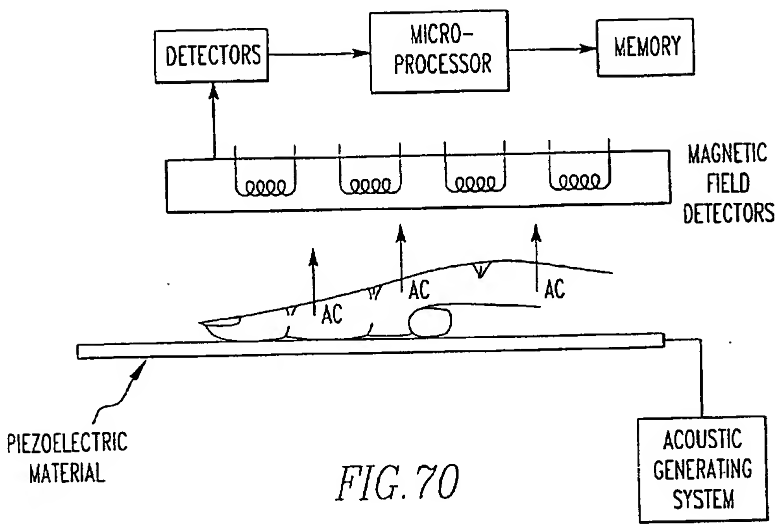

DETECTORS
MICRO-PROCESSOR
MEMORY
MAGNETIC FIELD DETECTORS
AC
AC
AC
PIEZOELECTRIC MATERIAL
ACOUSTIC GENERATING SYSTEM

FIG. 70

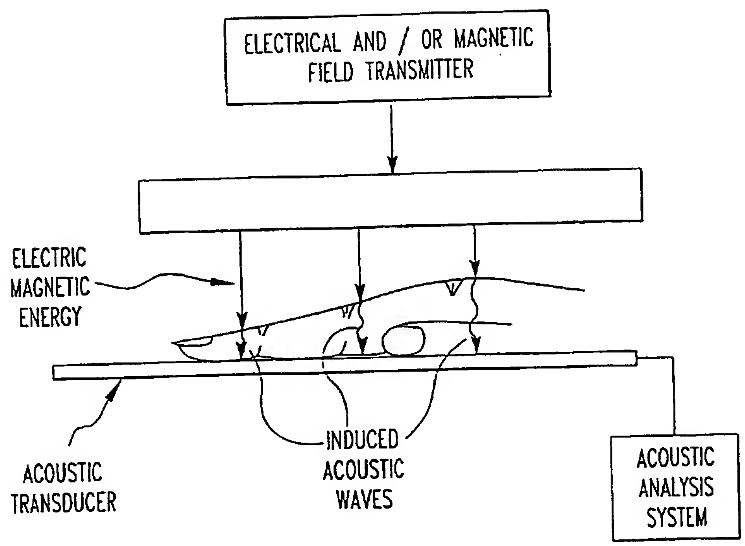
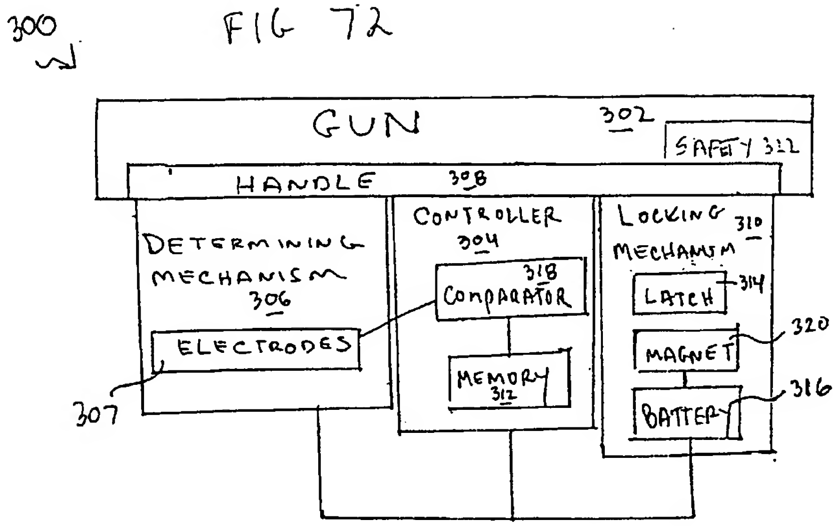

ELECTRICAL AND / OR MAGNETIC FIELD TRANSMITTER
ELECTRIC MAGNETIC ENERGY
ACOUSTIC TRANSDUCER
INDUCED ACOUSTIC WAVES
ACOUSTIC ANALYSIS SYSTEM

FIG. 71

FIG 72


300
GUN 302
SAFETY 322
HANDLE 308
DETERMINING MECHANISM 306
ELECTRODES
307
CONTROLLER 304
318
COMPARATOR
MEMORY 312
LOCKING MECHANISM 310
LATCH
314
MAGNET
320
BATTERY
316

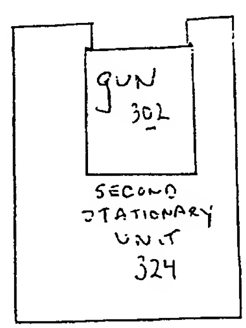

GUN 302
SECOND STATIONARY UNIT 324

FIG 73

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/24814

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G06K 9/00
US CL :382/100, 103, 106, 115, 116, 119, 120, 126
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 382/100, 103, 106, 115, 116, 119, 120, 126

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
BRS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,812,252 A (BOWKER et al.) 22 September 1998, col. 53, lines 27-31. col. 55, lines 44-55. col. 56, lines 24-37. col. 56, lines 56 -63. col 57, lines 1-9.	1-8
Y	US 5,719,950 A (OSTEN et al.) 17 February 1998, col. 2, lines 54-65 . col. 2, lines 54-65 . col. 4, lines 60-65.	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 FEBRUARY 2000	03 MAR 2000

Name and mailing address of the ISA/US	Authorized officer
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